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Field testing of gasifier based Italian oven (Siddlaghatta cottage basin) prototype

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1

Introduction

1.1 Background: summary of earlier project

In the earlier projects sponsored by SDC under its SERI-2000 programme TERI had successfully developed gasifier-based systems for cottage basin silk reeling ovens as well as dyeing ovens. In the last phase of the project, as an extension of the activity in the silk reeling industry, it was decided to develop a gasifier-based system for Italian cottage-basin reeling unit in Siddlaghatta. The Siddlaghatta cluster is considered to be the best quality silk yarn producing cluster of Karnataka on account of certain special characteristics such as stiffness, lower sericin content etc. and therefore Siddlaghatta silk fetches higher premium price in the market. The process of cocoon cooking and silk yarn reeling as well as layout of the unit is quite different here from that adopted in other silk reeling clusters of southern India. There is no separate re-reeling process and silk yarn is directly wound on standard size reel located behind the reeler. The cooking and reeling basins are located in the same masonry structure at one place and cooking person and reeler work simultaneously on its two opposite side. The cocoon cooking oven design adopted in Siddlaghatta cluster is also quite different from other silk reeling clusters and is called as Italian cottage basin oven (Figures 1.1 and 1.2). One Italian oven system, called as table, consists of one cooking basin and associated two reeling basins.

In the last phase of the project, an extensive survey of over 60 Italian basin ovens in Siddlaghatta cluster was carried out. This was followed by detailed energy audit of selected units to understand the specific process requirements and the present energy use pattern in order to obtain design base data to develop an alternate gasifier-based system. The specific fuel consumption and average useful power level of these ovens was found to be 2.49 (± 0.30) kg of fuelwood per kg cocoon processed and 2.31 kW_{th} respectively. The operating thermal efficiency levels of conventional Italian cooking ovens were observed to be in the range of 7 to 15%.

Considering the field level conditions/limitations (frequent power cuts, small capacity - 4 reeling basin user) it was decided to develop an updraft gasifier design. The major advantages of the updraft gasifier design include: ability to accept relatively larger size cutwood pieces (less fuelwood cutting

Figure 1.1. Conventional Italian basin oven (front view)

Figure 1.2. Conventional Italian basin oven (side view)

requirement) and requirement of relatively low power blower for its operation (can even be operated on natural draft mode without necessity of having electrical backup). Based on the design base data obtained through extensive field monitoring of traditional Italian ovens, a laboratory prototype of the gasifier-based Italian basin oven (Figure 1.3) was successfully designed, developed and tested under laboratory conditions at TERI's Gual Pahari campus during the last phase of the project.

Figure 1.3. Laboratory prototype of gasifier based Italian oven

1.2 Objectives

The over riding objective of this phase of the project was to carry out extensive field testing of the gasifier based Italian basin systems in selected units to monitor its performance under actual field conditions and quantify the benefits in order to assess its techno-economic feasibility.

Following are the list of activities listed in the original project proposal submitted in order to achieve these project objectives:

- Selection of sites in consultation with DoS-Karnataka
- Preparation of system specifications, drawings and construction manual
- Fabrication and construction of gasifier-based oven
- Trial test runs and modifications of the system

- Comparative data collection and quantification of benefits of gasifier based system over conventional system.

Following sections give a detailed account of the project activities undertaken in order to achieve fruitful completion of the project to achieve project objectives.

1.3 Chronology of project activities

April 2001

- Finalization of gasifier based Italian basin prototype unit configuration for field testing at Siddlaghatta

May 2001

- Trial runs on gasifier based system prototype unit constructed at TERI's Gual Pahari campus

June 2001

- Preparation of detailed specifications and drawings of various gasifier system components for its fabrication

July 2000

- Request to DoS Karnataka for assistance in finalization of field testing sites at Siddlaghatta

September 2000

- Response received from DoS Karnataka for site selection
- Visit to Kolar and Siddlaghatta for field testing site selection
- Selection of two field testing sites (Mr B M Gurumurthy and Mr Anantha Padmanabha) at Siddlaghatta

October 2000

- Signing of MoU (agreement) between TERI and identified reelers for carrying out field testing of gasifier based system
- Issue of purchase order for fabrication of two gasifier field prototype units to M/s 2 M Industries, Mumbai
- Submission of Bi-Annual project monitoring report for the period ending 30th September 2001

November 2000

- Fabrication of gasifier systems at 2M Industries, Mumbai under supervisio of TERI's technical staff
- Transportation of the two gasifier units from Mumbai to TERI-SR, Bangalore

December 2000

- Fabrication of gas carrying ducts at M/s Vijay Engineering, Bangalore as pe the dimensions to suit for existing system layout at both sites in Siddlaghatt
- Transfer of gasifier system components from Bangalore to field testing sites at Siddlaghatta
- Modifications at field testing sites to accommodate gasifier system in existing Italian basin layout
- Installation of system at both selected sites
- Trial runs at both the field testing sites
- Extension of gasifier flaring pipe above existing reeling shed
- Start of comparative field performance monitoring data collection of traditional and gasifier based Italian ovens

January 2001

- Arrangement of dry cut wood from nearby areas around Siddlaghatta
- Fabrication and installation of arrangement to run blower required for gasifier operation through belt-pulley mechanism driven by existing reeling shaft at Mr Anantha Padmanabha unit
- Continuation of comparative field performance monitoring for data collection at Mr Anantha Padmanabha unit

February 2001

- Fabrication and installation of belt-pulley mechanism to run blower using existing reeling shaft at Mr Gurumurthy unit
- Continuation of comparative field performance monitoring for data collection at Mr Gurumurthy and Mr Anantha Padmanabha unit

March 2001

- Continuation of comparative field performance monitoring for data collection at Mr Gurumurthy and Mr Anantha Padmanabha unit
- Project review meeting at SDC, Bangalore

- Meeting between TERI professionals and users at Siddlaghatta to get feedback on field performance of gasifier systems

April 2001

- Modification of gas carrying duct at Mr Anantha Padmanabha unit to avoid disturbance in movement of operators in the reeling unit
- Continuation of comparative field performance monitoring for data collection at Mr Gurumurthy and Mr Anantha Padmanabha unit
- Submission of Bi-Annual project monitoring report for the period ending 31st March 2001

May 2001

- Continuation of comparative field performance monitoring for data collection at Mr Gurumurthy and Mr Anantha Padmanabha unit

June 2001

- Continuation of comparative field performance monitoring for data collection at Mr Gurumurthy unit
- Compilation and analysis of comparative field performance data collected
- Organization of design review workshop on gasifier based Italian (Siddlaghatta type) oven at Siddlaghatta.

2

Development of field prototype unit

After successful development of laboratory prototype of gasifier-based Italian oven system at TERI and its trial testing under laboratory conditions in last phase of the project, it was decided to test it under the actual field conditions. The major objective is to monitor the system performance under field conditions, quantify the benefits as well as to get useful user feedback in order to carryout further development of the system to arrive at final system configuration which will not only be acceptable to the reelers but also user-friendly.

During the trial testing of the system under laboratory conditions, the main objective was to verify the proof of concept. i.e. whether gasifier system can provide the required power levels (and useful heat) for cocoon cooking and whether there is scope to achieve substantial fuelwood saving at these power levels (lower wood burning rate than the existing fuel consumption levels in conventional Italian oven). Once this goal was achieved it was necessary to fine-tune the system design to arrive at the "Mark 1" field prototype design from "Mark 0" laboratory design developed in the earlier phase. The attention was given to further simplify the system configuration so that it would be easy to fabricate by manufacturer as well as easy to operate by reeler under field conditions.

Following sections describe the various modifications made in the design of "Mark 0" laboratory prototype to arrive at "Mark 1" field prototype design:

Gasifier shell

In the "Mark 0" system the gasifier was made up of two cylindrical parts. Lower cylindrical portion was the main reactor of gasifier and top additional cylindrical piece was to have additional fuelwood storage. Two cylinders were joined using water seal arrangement/mechanism. But to simplify the system design it was decided to make gasifier with single cylindrical shell of height, which would accommodate fuelwood for 3-4 hours gasifier operation so as to have continuous gasifier operation in a the normal batch duration followed in the reeling units.

Reactor and grate diameter

The gasifier shell diameter was increased so as to have sufficient firecrete insulation thickness and also to have larger inner diameter to accommodate little larger size cutwood pieces. This will also allow larger grate diameter enabling use of thicker gauge rods for grate and still allow same effective grate open area to provide sufficient air for wood gasification to produce required quantity of combustible gas.

Gas outlet location

In order to ensure smooth gasifier operation under natural draft mode the vertical distance between air inlet and gas outlet was further increased. This also allows more residence time for gas within gasifier, which helps to some extent in reducing impurities (tar and particulate matter) in the combustible producer gas.

Air inlet opening

In the field prototype unit two air inlet openings are provided instead of one. Smaller air inlet (1.5-inch socket) is provided to connect air blower to gasifier. Larger air inlet (4-inch socket) is provided to enable operation of gasifier under natural draft mode and the same can also be used to remove ash and charcoal occasionally.

Damper position

In the earlier system the dampers in gasifier outlet ducts were placed horizontally (damper rotates along the horizontal axis). Though the handle of the damper was so placed that under its natural weight the damper will remain in its normal position viz. The damper which controls gas going to burner will remain in open position and the one in a duct which carries gas to chimney or flaring pipe will remain in closed position. But still during ignition or fuel-charging period the operator has to hold it so as to allow gas to go to chimney and prevent it from going towards burner. Therefore in the field prototype unit the damper rod is placed vertically so that damper can stand in any position and won't close or open on its own due to its own weight.

Burner port

At TERI both conical burners without any burner port plate as well as square burner with burner port plate having matrix of circular holes could be operated successfully to give consistent stable operation and desired useful power levels.

Though conical burner works very well under forced draft mode it was observed that the flame is not very stable under natural draft mode. Also the flame gets lift off easily due to external wind effect. Therefore it was finally decided to go ahead with square burner with series of burner portholes. Through trial runs the diameter and matrix of number of burner portholes were finalized.

Gas carrying ducts:

In order to simplify maintenance of gas carrying ducts (to remove tar and suit deposition in it if any over a period of time during field operation) opening with flanges were provided at many strategic bends so that these end flanges can be removed and duct can be cleaned easily.

Preparation of system specifications and technical drawings

Once the system configuration and design of the field prototype was finalized after incorporating the modifications mentioned above in the "Mark 0" laboratory prototype unit in order to arrive at "Mark 1" field prototype unit the detailed specifications as well as technical drawings were prepared. Detailed technical drawings included sub-assembly drawing showing how the gasifier and producer gas burner system will look like after assembly of all its components and other drawings to give details of various system components. This would make it easy for manufacturer to fabricate various system components accurately as per the design and also for checking the dimensional accuracy of manufactured system components to maintain quality control.

Detailed technical drawings of gasifier ("Mark 0" a well as "Mark 1") system along with other components such as burners, gas carrying duct, flaring pipe, burners etc. are enclosed in Annexure 1.

3

Planning for field testing of gasifiers

A preliminary tour was undertaken by TERI staff in the field to Siddlaghatta for selection of field testing site in consultation with DoS-Karnataka and in order to plan and make arrangements for smooth conduct of extensive field testing for quantification of benefits of the gasifier-based system over that of the conventional Italian basin oven.

3.1 Selection of field testing sites

As per the contract agreement the selection of sites for field-testing gasifier based system for Italian cottage basin ovens (Siddlaghatta type) was required to be done in consultation with DOS-Karnataka. Accordingly a request letter was sent to Commissioner for Sericulture Development and Director of Sericulture requesting to assist in finalizing the field testing sites. After receiving response in the first week of September 2000 asking to contact the Deputy Director Sericulture, Zilla Panchayat, Kolar and the Sericultural Extension Officer, Technical Service Centre (Reeling), Siddlaghatta for this purpose visit was made by TERI team to Kolar and Siddlaghatta.

First the team went to DD, DOS-Kolar District office and had meeting with Mr Puttana and briefed him about the progress made so far in developing the gasifier based system for energy efficiency improvement of Italian cottage basin oven and about the objective of the present visit. Since Mr V L Lamani, Sericulture Extension Officer (Reeling), Siddlaghatta was away for attending some training workshop in Chikaballapur, TERI team met Mr V L Krishna Murthy, Sericulture Inspector, Siddlaghatta and briefed him about the progress made so far and objective of the mission. He was also informed about the detailed energy audit work carried out previously at Mr B M Gurumurthy and Mr M S Jnaneshwar unit in Siddlaghatta during the last phase of the project.

Mr Krishna Murthy then took the TERI team to show some potential reelers where field testing of the gasifier unit can be carried out in the current phase of the project. Team was told that Mr Jnaneshawar is now looking after twisting unit after division of reeling and twisting unit and therefore that unit was not shown to the team this time.

Following is the list of the potential reeling units visited for site selection along with few comments/observations:

1. *Mr B M Gurumurthy, Kote, Siddlaghatta*

This was one of the units where TERI team carried out detailed energy audit experiments during earlier phase of the project. There are two sets (each containing 6 reeling basins) of Italian ovens having 3 tables (one table contains one cooking basin and two reeling basin) each. One set is newly constructed while the other one is little old. Offer was made to spare any one set as per requirement or even construct entirely new oven to suit for gasifier system installation. There is very large open space where it was told that the new oven could be constructed. The reelers seems to be quite progressive as he constructed *ushnakoti* also and on his own quite few modifications were tried out in order to improve its performance.

2. *Mr K N Jagannath, Kadripallya, Siddlaghatta*

Though the reeler has shown interest in testing the gasifier the site was too congested and gasifier installation could have blocked the passage of workers in the reeling unit. So it was thought not to consider this site for field testing as lot of trials, modification and experimentation may have to be done for which the available space was thought quite less.

3. *Mr Anantha Padmanabha, Kadripallya, Siddlaghatta*

In this unit there are in all four tables (4 cooking basins, 8 reeling basins) and it was told that the reeler is one of the progressive reeler in Siddlaghatta. Though here very large space like Mr Gurumurthy is not available around the tables, but it is not too congested also. There is sufficient space available in front of the tables and it was felt that gasifier can be accommodated without much problem.

4. *Mr S Buddan, Vijayalakshmi Talkies Road, Siddlaghatta.*

This site was also quite congested and there was not sufficient space to install gasifier. Also it was felt that the reeler has lot of unpleasant experiences and feelings about government programmes in general and specially for the development of sericulture in particular.

Finally in consultation with local TSC officials it was decided to short list following two sites for field testing gasifier unit at Siddlaghatta and forward it to DD Kolar who in turn will forward it Commissioner and Director in Bangalore.

1. Mr B M Gurumurthy
S/o Mr B Narayanappa,
Kote, Siddlaghatta
Phone: 08158-56430

2. Mr Anantha Padmanabha
S/o K Venkata Swamy,
Kadripallya, Siddlaghatta
Phone: 08158-56657

3.2 Agreement with selected reelers for field-testing

In order to ensure smooth conduct of field testing at selected sites, formal agreements were made between TERI and selected reelers for field-testing gasifier system with TSC officials as witness to these agreements. The salient features of the agreement are as follows:

TERI will provide the following for the purpose of demonstration and testing:

a. Gasifier system for Italian cottage basin oven along with other subsystems such as gas distribution duct, gas burner, blower
b. Installation and commissioning of the system and associated modifications required
c. Training for the operators at the field testing site for short duration at the start to help them learn new technology. However it is expected that once the operator gets trained the reeler will ensure that the gasifier system is operated regularly for its long duration performance evaluation.

For successful field testing of gasifier system for ascertaining its performance following is to be ensured by the reeler:

a. Utilities like power, water, cut wood (2-3 inch size and <15% moisture content).
b. Supply of cocoons during testing of the system
c. Operators and other field staffs required for running the system

d. Free access of personnel from TERI to collect field-testing data of both traditional as well as gasifier system for comparative performance evaluation etc.
e. Shelter for the gasifier system

Other important points included in the agreement are as follows:

- The gasifier system details and other know how provided to reeler under this agreement will be kept as confidential information and reeler will not disclose the design/drawings/data to any other person/parties.
- After the expiry of the field testing period reeler may decide to purchase the system by paying cost of the system to TERI at depreciated price, otherwise TERI will have an option of withdrawing the system from the premises.
- Since there is present practice of using dry cut wood in Italian basin, it is expected that the reeler will make arrangement to ensure supply of cut wood, 2-3" size with less than 15% moisture content from the present cut wood fuel supplier. Since even pruning can be used in gasifier as fuel which are cheaper than woodlogs it is expected that even after cutting into smaller size it would cost same. However, if required the additional cutting cost can be reimbursed to the reeler for the trial period for comparative performance evaluation. Once the fuel saving potential is proved then reeler is expected to bear this extra cost as overall it is expected that fuel cost in absolute term may reduce.

Copy of the formal agreement signed between TERI and selected reelers for field testing of gasifier based Italian oven namely Mr Gurumurthy and Mr Anathapadmanabha of Siddlaghatta is enclosed as an Annexure 2.

3.3 Fabrication of the field prototype units

After finalization of the field prototype system configuration and preparation of design specifications, detailed technical drawings, the purchase order was given to M/s 2M Industries, Mumbai (who is also one of the licensed gasifier manufacturer for SERI-2000 oven and gasifier for cottage basin as well as dyeing system) for fabrication of gasifier system and associated sub-components of field prototype Italian oven system in October 2000.

One set of detailed technical drawing was sent to initiate the fabrication activity in their workshop. Once major portion of the fabrication work was completed TERI team made visit to workshop for quality check. Final finishing touches for fabrication of gasifier as well as other associated system components were given under supervision of TERI's technician in November 2000. Gasifier insulation was carried out in Mumbai itself with ACC "Whyteheat C" castable insulating material in presence of TERI technician.

After proper curing of gasifier insulation material as per procedure recommended by ACC the system components were packed and despatched to TERI, Bangalore office in the first week of December 2000.

4

Field installation and commissioning

After completion of the fabrication of all system components and gasifier insulation casting work was completed at M/s 2 M Industries, Mumbai the system was transported by road to TERI's Bangalore office for field installation.

Preparation of field testing sites

A visit was made to field testing sites to measure various dimensions of the existing oven set up as well as present layout of the unit. This was to finalize which two adjacent tables (Italian basin ovens) will be coupled to the gasifier for field testing purpose. Though the gasifier system was to be fitted as an add-on attachment to existing conventional Italian oven few modification in it at the site were necessary.

In order to accommodate gasifier in the present set up and also to enable its operation under natural draft mode it was necessary to dig a pit in front of the Italian basin in between two tables. This is required to position the gasifier at lower heights so that its gas outlet is positioned in such a way that the burner could be placed below cooking vessel as its bottom centre (Figure 4.1 and 4.2). Accordingly instructions were given to the reeler and supervisory staff of the unit.

Fabrication of gas carrying duct

Depending on the position of gasifier relative to the existing cooking basins and distance between the two tables, lengths of gas distributing duct and individual burner arms for both the units were finalized. Drawings/sketches for gas carrying duct pieces were prepared. The gas duct pieces were got fabricated from workshop of M/s Vijay Engineering Works located at Pennya Industrial Estate in Bangalore.

After completion of duct fabrication and required site modifications the gasifier system along with its all components were transported to both the sites located in Siddlaghatta.

Figure 4.1 Gasifier installation in a pit at Gurumurthy unit

Figure 4.2 Gasifier installed in a pit at Anantha Padmanabha unit

System installation and trial runs

Once all the system components were brought to the site and site preparation work got completed the individual systems were assembled. The gasifier system was first assembled at Mr B M Gurumurthy's unit and then at Mr Anantha Padmanabha's unit. Since by this time arrangement for local supply of cut wood was not arranged from saw mills in or around Siddlaghatta for initial trial runs dry cutwood pieces were purchased from sawmill in Ramanagaram and brought to Siddlaghatta by metador.

The main objective of the trial runs was to check and also to show to the reelers as well as operators that the gasifier operates satisfactorily under field conditions and supplies adequate amount of useful heat to boil water in cooking basin. The other objective was to fine tune the system for extended field testing to collect comparative data for quantification of benefits based on experience gathered through these trial runs (how system performs under field conditions) and based on user (reeler as well as operators) feedback.

Initially the reelers and operators were briefed about gasifier system and technology. Efforts were made to explain to them what is gasifier?, what is its operating principle?, how it is different from oven (converts wood into gas that in turn is utilized)?, what are its possible advantages? (controlled operation, consistent uniform heating, less smoke so improved working conditions, etc), and type of fuel required (dry, cutwood pieces of 6 inches in size) and what will happen if wet or large sized wood is used in the gasifier?.

Few dry trial runs (without cocoon cooking) were carried to train local operators on how to start the gasifier operations which included charging fuelwood, igniting fire, testing production of combustible gas by flaring in chimney pipe, operating various dampers provided in different gas ducts, managing flame in burner by controlling air supply (both primary and secondary) etc.. Training was also given on some troubleshooting measures required to overcome some common problems, which may be faced while operating the gasifier system. These included blocking of grate by ash, fuel bridging within the gasifier due to feeding of large size wood pieces and unstable flame in the burner due to excess/inadequate supply of air etc.

Fine tuning of gasifier system

Though the trial testing of gasifier system in reeling units helped to create awareness about the new technology among users and convince them about its potential benefits following apprehensions were raised by the reelers and/or operators of the reeling unit regarding gasifier system operation:

- Smoke emitted from gasifier chimney which fills up into reeling shed can affect quality of silk yarn due to deposition of tar
- Burner flame without premixing of air may be insufficient for faster cooking
- Leakage of smoke through damper in chimney duct may affect the quality of silk yarn
- The burner arms which goes inside the oven may disturb the movement of cooking person or supervisor
- Operation of gasifier (blower) during the power cut (though it was showed that since now the system is located at lower elevation it can be operated under natural draft mode reelers felt it may not give high power levels)

In order to overcome some of the reeler's apprehensions following on site additions/modifications were made in the system configuration:

- The shorter chimney duct was replaced with long 2.5-inch diameter GI pipe that was extended above the shed/roof in order to take the smoke away from the reeling shaft and above reeling unit shed.
- Each burner was provided with small flexible air pipe with valve to provide additional controlled quantity of premixed air to burner along with gas.
- In order to eliminate the leakage of smoke through damper in chimney duct a 2.5-inch diameter ball valve was introduced into the chimney pipe.

Modifications to enable operation during power cut

Updraft gasifier design can be operated under natural draft mode by opening 4-inch diameter socket. However reelers felt that it may not give high power rates required for faster processing of cocoons and so operators may feel hesitant to use gasifier system during power cut period due to fear of lowering production rate. Also during trial runs it was thought that if comparative data of conventional and gasifier based Italian oven system is to be collected it would require gasifier operation with power back up during power cuts which are quite frequent in the region. Also considering reeler's apprehension about gasifier operation in the absence of power (required for blower, which supplies air to gasifier as well as burner) it was decided to work out an alternative arrangement to enable the gasifier operation without power back up before starting the extensive comparative data collection experiments. Though this may result in slight delay in time schedule of project activities planned, but if could be achieved would also help in overcoming major barrier (necessity to have power back up for gasifier operation) in promoting gasifier system and will enhance acceptance of the new gasifier technology by users.

As mentioned earlier updraft gasifier can even be operated under natural draft mode and even in forced draft mode small capacity blower is required basically to ensure consistent supply of air which may not be achieved perfectly under natural draft mode due to natural fluctuations in ambient environment. In the event of power failure the reelers either uses kerosene engine to run the reeling shaft or some units even rotate it manually. Since very little power is required to run the blower (required for updraft gasifier operation), it was decided to use blower with pulley on its shaft, which can either be coupled to the pulley on motor shaft or to the pulley on any one of the shafts of existing reeling mechanism of the unit. The sizes of the pulley (pulley diameter ratio of driver and driven shaft pulley) is so selected that the blower rotates at normal speed (RPM) in order to supply sufficient quantity of air required for operation of updraft gasifier and producer gas burner. Thus now whenever reeling shaft is rotated by alternate arrangement adopted by the reeling unit during power failure, the gasifier blower can also be operated; by coupling blower shaft through belt-pulley arrangement.

Blower belt-pulley arrangement: Gurumurthy unit

In Gurumurthy's reeling unit there are two sets of three tables each (total 6 cooking basins and 12 reeling basins). Kerosene engine and the electric motor to run the two reeling shafts of both the sets are located at the middle. There are several shafts with different sized pulleys, which are used to step by step reduce the RPM of individual shafts to their designated values.

The existing blower from TERI's Ramanagaram field office was brought to Siddlaghatta and modified to installed pulley on blower shaft. This modified blower with pulley was installed at the centre of the unit and coupled to the shaft located between electric motor and kerosene engine (Figure 4.3). The larger diameter pulley was installed on this middle shaft to get pulley diameter ratio so that the blower operates with about 2000 RPM. Thus gasifier is operated with electric blower under normal conditions and during power cut (when the reeling shaft is powered with kerosene engine) air blower is energized by coupling it to common reeling shaft through flat belt pulley mechanism.

Figure 4.3. Belt pulley arrangement for blower installed at Gurumurthy unit

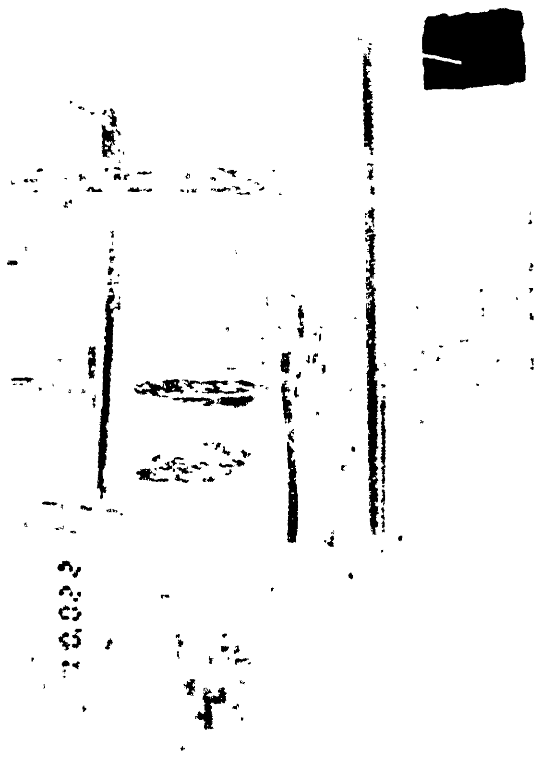


Figure 4.4. Belt pulley blower arrangement installed at Anantha Padmanabha unit

Blower belt-pulley arrangement: Anantha Padmanabha unit

There are four tables (4 cooking basins and 8 reeling basins) in Anantha Padmanabha's reeling unit. The common reeling shaft is driven by an electric motor located at one end of the reeling shaft (Figure 4.4). The kerosene engine is also located there in the corner. During power cut the reeling shaft is coupled to the kerosene engine by changing belt-pulley combinations. Therefore here the air blower with pulley on its shaft was placed in the corner so that it can be coupled to common shaft driven by kerosene engine during power failure to supply air required for gasifier system operation. Since the shaft here was extruding outside the reeling mechanism frame the pulley installed to couple blower had to be located with an overhanging shaft. So the bearing of the old shaft were also required to be changed to take care of the additional blower load on the common reeling shaft. The diameters of the pulleys installed on the reeling (driver) shaft and blower (driven) shaft were so selected that (larger diameter pulley on driver shaft and smaller diameter pulley on driven shaft to increase blower RPM) the blower delivers sufficient air required for gasifier and burner operation.

Positioning gas duct underground

In the review meeting held with the reelers in March 2001 the supervisor at Anantha Padmanabha unit complained about the disturbance in movement between various tables due to gas duct branches going inside the ovens. The main purpose of inserting gas burner duct through existing fireplace of conventional oven was to avoid modifications in the existing oven masonry structure and show gasifier system as a retrofit option. But in order to overcome this problem the gasifier position in Anantha Padmanabha unit was further lower so that the gas distributing ducts can be placed at ground level.

Arrangement of dry cutwood supply

In order to ensure regular supply of dry cutwood, survey of briquetting plants as well as saw mills was carried out in and around Siddlaghatta. There is a biomass briquetting plant installed in the outskirts of Siddlaghatta but is closed for quite some time due to plant maintenance problem and also the briquette costs are quite high (about Rs 1600-1800 per ton) compared to present cutwood cost of about Rs 1400 per ton. Therefore option of using biomass briquettes in the gasifier to avoid cutwood problem was ruled out.

After extensive search of sawmills in and around Siddlaghatta two saw mills could be located (one in Vijayapura and other in Chikaballapur) who agreed to supply cutwood pieces of size (5 to 6 inch) required for gasifier operation. Surprisingly, both these saw mills agreed to supply cutwood pieces at the rate of Rs 1400 per ton, which is almost equal to the present rate of firewood (cutwood pieces of about 12 to 18 inches in size) that reeler purchases in Siddlaghatta for using it in the conventional Italian ovens. This may be due to the fact that for making the small cutwood pieces the sawmill waste wood (side cutting pieces) and pruning which are normally available at lower prices in the market can be used. Additional transportation cost works out to about Rs 50 to 60 per ton (Rs 175-200 per metador of about 3-4 ton wood carrying capacity or Rs 275 to 300 per truck of about 5-6 ton wood carrying capacity).

5

Field performance monitoring

After installation of gasifier systems in the field and ensuring uninterrupted system operation by putting in place the belt-pulley mechanism for energizing air blower required for gasifier operation even during power failure the work on extensive field performance monitoring of gasifier system was commenced. Since lot of time and efforts had gone in achieving this unplanned activity of developing belt-pulley blower mechanism the work of comparative data collection got delayed. Also due to labour problem and also sometimes due to scarcity or availability of very poor quality cocoons in the market reelers had to close down the unit occasionally. This further delayed the process of comparative field performance data collection. Therefore project duration (which was scheduled to be completed by March 2001) had to be extended by three months till June 2001.

The main objective of the field performance monitoring was not only to monitor the gasifier performance under actual field conditions but also to compare it with that of conventional Italian basin ovens in order to arrive at techno-economic feasibility of the proposed intervention.

5.1 Approach for comparative data collection

In order to collect the comparative performance data of conventional as well as gasifier based Italian oven system it was necessary to minimize the variations in operating parameters during the data collection on both the systems to the extent possible. The possible parameters which may vary includes variation in type of cocoons as well as its quality, variation in ambient conditions (temperature, humidity etc) due to weather change, skill of operators, quality of water etc.

While collecting the comparative performance data efforts were made to minimize the variations in operating parameters to the extent possible. In order to achieve this same cocoon lot was used to avoid variation due to cocoon quality and the comparative data on both the systems were collected on the same day to minimize variation due to ambient weather parameters, possible variation in quality of water used on different days etc. Efforts were also made to change operators, specially cooking persons, on different cooking basins randomly to the extent possible so that the error due to skill of the operator may get neutralised over large number of data points.

5.2 Comparative performance data collection

With the above mentioned approach and precautions (to have unbiased rational findings), comparative field performance data on conventional as well as gasifier based Italian oven was collected from two field testing sites namely Gurumurthy and Anantha Padmanabha for as many days as possible. Two personnel were dedicated to collect the comparative field performance data at the two selected sites in Siddlaghatta. Extensive training was given on how to operate the gasifier system as well as carrying out trouble shooting required during operation of the gasifier system. For first few days of field performance monitoring both were trained well on carrying out experiments as well as monitor and collect comparative performance data.

A detailed data sheet was prepared for collecting the data on both conventional and gasifier based cottage basin for several batches in a day. The format of the data sheet is enclosed in Annexure 3. The summary of daily comparative performance data of both (Gurumurthy and Anantha Padmanabha unit) field testing sites is enclosed in Annexure 4.

The data sheet consists of following major sections:

- General information:
  - unit monitored, investigator, experiment code number, date
  - ambient temperature, weather conditions
  - type of wood used, moisture content, calorific value
  - quality of cocoons, type of stifling method followed
  - no of cooking and reeling basins monitored for conventional and gasifier based system
  - time of gasifier ignition, flame stabilization, starting and stopping of cooking operation, oven shut down etc.

- Information was collected for each cooking batch of operation:
  - Fuelwood consumption: amount wood added along with time, total wood consumed and duration
  - Cocoon measurements: initial and balance weight of cocoons, net quantity of cocoon processed and duration,

- Silk yarn measurement: net amount of silk produced on each reeling basin
- Silk waste measurement: net amount of silk waste (jute waste) produced per table after proper drying
- Water measurement: net quantity of water consumed in cooking as well as reeling basins

5.3 Field performance data analysis

While monitoring the field performance data, one or more cooking basins and reeling basins on conventional oven as well as gasifier based systems were monitored. However in order to carry out the analysis of the collected data for performance comparison and quantification of benefits between conventional and gasifier based Italian oven comparison was made for two cooking basins (or four reeling basins). This is done since one gasifier system is designed to provide sufficient combustible gas for two tables (two cooking basins and four reeling basins) of Italian oven, which is found to be the average size of the unit in the earlier studies.

On each day comparative data was taken on both traditional and gasifier system for one to three batches operated on that day and a cumulative daily data was compiled. In all the comparative data could be measured for 17 days and 37 days in Gurumurthy and Anantha Padmanabha unit respectively. Less number of data points at Gurumurthy unit are mainly due to closure of the unit for many days due to labour problem and also sometimes due to scarcity of good quality cocoon in the market. The comparative performance data at these two units is summarized in Table 5.1.

From the comparative performance data it can be concluded clearly that the gasifier based system is much more energy efficient and the fuelwood saving ranges in the range of 38.5 to 42.5%. Since the cocoon processing rate varies from basin to basin and depending on variety of factors as well as skill of operators, the fuelwood saving is compared both on specific fuel consumption basis (kg wood per kg cocoon processed) as well as on wood consumption rate basis (kg/hr per cooking basin). It can be seen that in these two units the fuelwood savings are quite close for both type of comparison.

It can also be observed from the data that there are indications that there is an improvement in the silk yarn productivity or yield though the increase in absolute term may be small. The percentage increase in silk yarn yield of the order of 1.70 and 0.36 percentage could be observed (due to improvement in renditta) in Gurumurthy and Anantha Padmanabha unit respectively. There was not much significant difference observed in terms of cocoon processing rate or silk yarn production rate (though latter increased slightly due to improvement in renditta) to conclude.

Table 5.1: Summary of comparative field performance data

	Gurumurthy			Anantha Padmanabha		
	Conventional		Gasifier	Conventional		Gasifier
No of data points		17			37	
Specific fuel consumption	3.592		2.198	2.483		1.429
(kg wood per kg cocoon)	(0.845)		(0.477)	(0.763)		(0.445)
Wood saving (%)		38.497			42.392	
		(7.966)			(6.405)	
Wood consumption rate	5.961		3.618	6.034		3.462
(kg/hr)	(0.780)		(0.545)	(0.871)		(0.550)
Wood saving (%)		39.125			42.508	
		(6.157)			(5.606)	
Renditta	5.513		5.427	6.554		6.531
	(0.868)		(0.875)	(0.581)		(0.578)
Renditta improvement		0.087			0.023	
		(0.102)			(0.072)	
Percentage more silk yarn yield		1.704			0.357	
		(1.962)				(1.110)
Cocoon processing rate	2.007		1.995	3.000		3.062
(kg/hr)	(0.323)		(0.255)	(0.481)		(0.517)
Silk production rate (kg/hr)	0.366		0.373	0.457		0.468
	(0.042)		(0.044)	(0.060)		(0.066)

Note: Numbers in the parenthesis are standard deviation values

Though there is significant improvement in fuelwood saving (the variance is small compared to absolute difference in average value so there is less overlap of range of absolute values) so as to conclude statistically, there is large overlap in the renditta values. However reeler's appreciated the uniformity in the quality of silk yarn and also feel that there is definitely an improvement in the quality of silk yarn that can be attributed to uniform and consistent heating of water in cooking basin.

Reduction in heat loss from oven opening and surface

From monitoring of the various oven surface temperatures it was observed that though the surface temperatures of most of the surfaces are similar there is drastic reduction in the temperature of the front portion of the oven in case of gasifier based system (See Table 5.2). The higher surface temperatures in case of conventional Italian oven may be attributed to wood fire flames coming out from the front fuel port opening which heats it up to higher temperature.

Table 5.2. Temperature of front surface of italian oven

Sr No	Conventional oven	Gasifier oven
Gurumurthy unit		
1	85-118	29-47
2	78-120	26-32
Anantha Padmanabha unit		
3	52-64	31-35
4	52-95	30-45
5	50-94	31-42
6	52-74	29-38
7	58-80	29-40

The radiation heat loss from fuel port opening is also quite low in case of gasifier based system as the high temperature gas burner flame is located close to cooking vessel bottom surface deep inside from oven fuel port opening. In case of conventional wood fired Italian oven the flame is spread all along the grate and sometimes flame even comes out from the fuel port opening resulting in huge radiation loss.

Heat loss associated with flue gases

At regular intervals data was collected for flue gas temperature at exit of the chimney and the chimney surface temperature (Figure 5.1). Table 5.3 gives sample representative data collected for few days of operation at Anatha Padmanabha unit.

Table 5.3: Flue gas and chimney surface temperature (°C)

Sr No	Conventional oven		Gasifier oven	
	Flue gas	Chimney surface	Flue gas	Chimney surface
Gurumurthy unit				
1	225-300	42-62	203-230	38-44
2	208-250	45-52	159-200	36-51
Anantha Padmanabha unit				
3	218-300	84-114	101-135	36-52
4	250-478	59-98	105-195	33-60
5	248-320	62-106	128-167	46-62
6		52-85		33-51

It can be observed from the Table 5.3 that flue gas temperature at chimney exit in conventional oven is substantially high (almost by 50-150 °C).

Figure 5.1. Monitoring of flue gas temperature in chimney

This clearly indicates that the heat loss through flue gases is one of the major heat losses in conventional oven resulting in its low operating thermal efficiency. In the gasifier based system the heat loss associated with flue gases is drastically reduced due to low excess air factor as well as low flue gas temperatures at chimney exit. The high heat content in flue gases also reflected in terms of higher chimney surface temperature of conventional oven. This in turn results in higher loss due to radiation as well as convection from hot chimney surface to ambient air.

Performance review meeting with reelers

In the month of March 2001 the meeting with the reelers was held at Siddlaghatta to get user feedback on the comparative performance data collecte by that time and also to get some useful feedback. During the meeting officials from TSC, Siddlaghatta as well as both the users of gasifiers participated in the meeting (Figure 5.2). All appreciated the performance of the system and felt that there is substantial fuelwood saving of the order of 25-50% as well as improvement in quality of silk yarn. However the reelers raised following apprehensions about gasifier system performance:

Figure 5.2. Review meeting with reelers and TSC officials

- The low availability of charcoal required for drying silk yarn while reeling
- There was fear that coupling of blower to existing reeling shaft run by kerosene engine may increase kerosene consumption substantially
- The reeling basin water temperature may be lower with the producer gas burner used in gasifier system
- The duct arms of burner going inside the oven structure may obstruct movement of personnel within the reeling unit

It was decided that the alternative viable option for silk yarn drying would be tackled later in the next phase of the project. As mentioned in earlier chapter the gas duct was lowered and made underground in Anantha Padmanabha unit so that there won't be any obstruction in movement of personnel in the unit. It was decided to collect some more data in Anantha Padmanabha unit to clarify other doubts raised by reeler's about basin temperatures as well as fear of more kerosene consumption, details of which are given in the following sections.

Kerosene engine fuel consumption

There was apprehension by reelers that by coupling the blower required for gasifier operation to existing reeling shaft run by kerosene engine will drastically increase the kerosene consumption and thereby reduce benefits due to fuelwood saving. In order to verify this doubt the kerosene consumption was monitored for fixed duration both with and without coupled to kerosene engine. The data collected for 3 days is compiled in Table 5.4. From the data it can be observed that, there is hardly 10% increase in the kerosene consumption (from 440 ml/hr to 486.6 ml/hr) level due to additional load of blower. However this set up avoids huge incremental cost which may be required to have an additional electrical back up (genset) to run the blower required for gaifier operation.

Table 5.4: Fuel consumption of kerosene engine

Sr No	Engine running without blower (ml/hr)	Engine running with blower (ml/hr)	Difference (ml/hr)
1	430	470	40
2	450	500	50
3	440	490	50
Average	440	486.6	46.6

Cooking and reeling basin temperatures

Since now gaseous fuel is burnt with controlled flame in combustion chamber of the oven instead of solid fuel burning reelers and supervisors were having doubt that the reeling basin water temperature is not sufficiently high compared to conventional unit. The reeling as well as cooking basin water temperature in both conventional and gasifier-based Italian oven was simultaneously monitored (Figure 5.3). The data collected for four days is in Anatha Padmanabha unit is compiled in Table 5.5. It can be observed that reeling basin as well as cooking basin water temperature in gasifier based system is almost same as that in conventional system. It was never observed lower but 1-2 degrees higher only in case of gasifier system as compared to conventional system.

Table 5.5: Cooking and reeling basin water temperature

Sr No	Conventional oven		Gasifier-based oven	
	Cooking basin	Reeling basin	Cooking basin	Reeling basin
1	90-93	42-54	90-96	41-51
2	90-94	42-48	89-97	43-49
3	85-94	43-48	84-96	43-51
4	90-93	45-53	91-96	45-61

Charcoal and water consumption

In order to clear the doubts about possible consumption of more water or charcoal, the comparative data was collected in Anantha Padmanabha unit for few days. The collected data is compiled in Table 5.6. It can be observed that

Figure 5.3. Monitoring of cooking basin water temperature

there is not significant difference in consumption of either water or charcoal. The minor variation observed can be attributed to natural variation from day to day and by operator to operator.

Table 5.6: Charcoal and water consumption (kg per cooking basin)

Sr No	Conventional oven Water consumption	 Charcoal consumption	Gasifier-based oven Water consumption	 Charcoal consumption
1	326	1.09	313	0.86
2	280	1.16	270	1.225
3	276	0.825	275	1.085
4	269	1.025	253	1.01
5	279		250	

Cost benefit analysis

Here in this section an attempt has been made to calculate the cost benefit analysis of gasifier based Italian oven system based on the extensive comparative field performance data collected during the field testing of gasifier based Italian ovens at Gurumurthy and Anantha Padmanabha unit. Since gasifier system has been designed to provide producer gas for two tables (two cooking basin and four reeling basin) the analysis has been done for two tables on daily basis based on the average value of various parameters observed during comparative performance monitoring.

Here quite conservative estimates and situations are considered to arrive at daily monitory benefits to reelers to arrive at simple payback period. Charcoal and kerosene consumption for entire day operation has been considered instead of considering only additional amount of charcoal (apart from that generated in gasifier) and kerosene (kerosene during power cut period) only. The data and results of the cost benefit analysis are summarized in Table 5.7 for both Gurumurthy and Anantha Padmanabha unit.

Table 5.7. Summary of cost benefit data analysis of gasifier based Italian basin oven

Particulars	Gurumurthy		Ananthapadmanabha	
	Conventional	Gasifier	Conventional	Gasifier
Cocoon processed (kg)	20	20	30	30
Average renditta (kg cocoon/kg silk)	5.513	5.427	6.554	6.531
Silk produced (kg)	3.628	3.686	4.577	4.594
Specific fuel consumption (kg/kg cocoon)	3.592	2.198	2.483	1.429
Fuel wood consumed (kg)	71.840	43.960	74.490	42.870
Charcoal consumed (kg)	0.0	1.2	0.0	1.2
Kerosene consumed (lit)	0.0	0.4	0.0	0.4
Fuelwood cost (Rs/kg)	1.4	1.5	1.4	1.5
Charcoal cost (Rs/kg)	4.00	4.00	4.0	4.0
Kerosene cost (Rs/lit)	18.00	18	18	18
Cost of fuelwood (Rs)	100.58	65.94	104.29	64.31
Cost of Charcoal (Rs)	0.00	4.8	0.00	4.80
Cost of kerosene (Rs)	0.00	7.20	0.00	7.20
Total fuel cost (Rs)	100.58	77.94	104.29	76.31
Additional silk produces (kg)		0.058		0.016
Silk cost (Rs/kg)	1450	1450	1450	1450
Daily fuelwood saving (Rs)		22.64		27.98
Additional daily income through Increases silk production (Rs)		83.36		23.37
Total daily benefits (fuel+silk) (Rs)		106.00		51.35

It can be observed from the cost-benefit analysis that in spite of lower processing rate the daily benefits works out to be higher in case of Gurumurthy unit as compared to Anantha Padmanabha unit mainly due to better improvement in renditta or silk yield. Daily benefit due to fuel saving alone works out to be Rs 12 to 14 per cooking basin (or table) which is quite substantial (about 25-30%) amount of present daily fuelwood cost per table.

Thus even with conservative incremental cost of the gasifier system of around Rs 15,000 the simple pay back period with fuelwood saving alone works out to 663 and 536 days respectively for Gurumurthy and Anantha Padmanabha unit. With 300 working days operation per year simple payback period with fuelwood saving alone would be about 2.2 and 1.8 years respectively. If the additional daily income due to increased silk yarn yield (due to improvement in renditta) is also taken into account the pay back period works out to 0.5 to 1 year, which can be considered as quite attractive.

6

Design review workshop

The main purpose of organizing the design review workshop was to review the progress made in the development of a gasifier-based Italian (Siddlaghatta cottage basin type) oven system in the present phase of the project and to plan the activities for the future. Another objective was to elicit comments/feedback from the concerned professionals from state government departments, reelers, manufacturers etc. on the system design as well as its performance under actual field conditions. This was necessary so as to assess the success of the prototype development and also to plan future course of action in order to arrive at a marketable and user friendly product for its large-scale promotion. This one-day design review workshop was organized on 12 June 2001 at Silk Exchange, Siddlaghatta to achieve these objectives. The participants of the workshop included officials from DoS-Karnataka, KSSRDI, TSC-Siddlaghatta, SDC (Swiss Agency for Development and Co-operation), Bangalore, manufacturers, and local silk reelers including the two gasifier users where comparative field performance monitoring of gasifier system was carried out. The programme schedule and the list of participants are given in Annexure 5.

Demonstration of gasifier based Italian oven

The main objective of the demonstration of gasifier in the silk reeling units was to introduce the gasifier system to other local reelers, government officials and other stakeholders at functioning levels. All the participants visited the demonstration in the morning before the beginning of the workshop proceedings. The participants asked many questions about functioning and performance of the gasifier system. The reeling unit owners and TERI team answered their questions. After completion of the demonstration, all the participants participated in the workshop organized at the Silk Exchange. The photographs in the Figures 6.1 and 6.2 show the visit of SERI-2000 team, reelers and other participants of the workshop to see gasifier system in operation during workshop demonstration at Gurumurthy unit.

Figure 6.1. Gasifier demonstration during workshop: Visit of SERI-2000 team

Figure 6.2. Gasifier demonstration during workshop: visit of several local reelers

Welcome address and brief introduction

Dr V V N Kishore, Senior Fellow, TERI, New Delhi welcomed all the participants namely reelers, SDC officials, Department of Sericulture officers and others to the design review workshop at Siddlaghatta. He mentioned that this workshop is being organized with support from SERI – 2000 programme of SDC and is being conducted at Siddlaghatta with co-operation from Department of Sericulture, Government of Karnataka. Dr Kishore briefed the audience about the gasifier developmental work carried out by TERI in past for Ramanagaram type cottage basin oven in different stages. He pointed out that there were considerable inputs from various stakeholders namely reelers, manufacturers, consultants and developers that resulted in the matured product. This development activity took nearly four years from prototype stage to final product.

Similarly, Siddlaghatta cottage basin being different type, TERI has taken up the task of developing a suitable gasifier based system for Italian oven. In this effort, TERI has collected data related to gasifier performance under field conditions over the last six months to quantify its benefit over conventional oven and the results are encouraging. He mentioned that other TERI team members would share their experiences about these results later in detail. He also hoped that this workshop would provide useful interactions between the various stakeholders concerned and will result in useful inputs that would lead towards development of a matured product.

Overview of project activities

In his presentation Mr Sanjay Mande, TERI, New Delhi gave a detailed step-by-step account of R&D efforts made by TERI in developing the gasifier based Italian basin oven system during last 2-3 years and the comparative performance details of the system monitored at two field testing sites in Siddlaghatta.

Initially, details of the indepth study on traditional Italian basin carried out by TERI in order to understand the present technology followed, its status and bottlenecks were explained. This included the extensive survey carried out on more than 60 traditional Italian basins to know present energy use patterns as well as details of energy audit results which helped in understanding the process requirements and design base needed to conceptualize and develop alternate technological intervention.

After explaining the status of traditional Italian ovens he moved on to explain efforts made by TERI in evolving the appropriate gasifier based alternative system design. Focus of presentation was on efforts made to evolve a system design, which will be suitable for field conditions. He said that considering the field level conditions (frequent power cuts, low capacity users having 3-4 basins) it was decided to develop an updraft gasifier design. The major advantages of updraft gasifier mentioned included, its ability to operate with little larger size cutwood pieces and low power blower (can even be operated on natural draft mode even in unelectrified location). He informed that in developing the system design attention was given not to intervene in its unique layout of Italian basin for which it is considered special and rather develop gasifier system as an attachment to existing oven structure with minimal modification if required.

Followed by this, details of laboratory trials carried out at TERI's gasifier system as proof of concept of updraft gasifier option were given. It was also explained how the system were installed and commissioned through process of trial runs and fine tuning of the system with user feedback. The stress was on relevance and importance of developing blower mechanism to enable operation of blower required for gasifier operation by coupling it to existing reeling shaft. This not only helped in continued operation of system for comparative data collection for long duration but also proved that additional high invest on generator is not essential for gasifier installation. This development ensured that with such minor modifications it can be ensured that whenever reeling operation is going gasifier system can be operated satisfactorily even during situations of power cuts.

Summary of the comparative performance monitoring to quantify benefits of gasifier system over conventional Italian oven were given. The major benefits observed included:

- Fuel wood saving of the order of 30-40%
- Improvement in working conditions
- Less smoky atmosphere and
- Less heat desipated in the reeling unit
- Improvement in quality of silk yarn; more uniformity
- Increased silk yarn yield (reduction in renditta)

The cost benefit analysis showed for Italian cottage basin oven indicated that even with conservative estimate of additional cost of Rs 15,000 the simple pay back period with fuelwood saving benefit alone works out to around 2 years. If the additional income due to increased silk yarn is taken into account the simple pay back period would be even less than a year which can be considered quite attractive.

At the end it was mentioned that there are still some improvements which will be essential in the system configuration such as mechanism to dry silk yarn effectively and efficiently before arriving at final system configuration for its large-scale commercialization.

Feedback from reelers

Mr Anantha Padmanabha

Mr Anantha Padmanabha mentioned that there were few problems during initial days with the gasifier system operation, but TERI team successfully solved them and the system has been in operation under the supervision of TERI team. His observations based on the experience he had on gasifier system during comparative performance data collection were:

- Gasifier operating performance is comparable to our conventional oven in terms of heat output rate and quality of silk yarn produced.
- Gasifier based system showed a fuel saving of about 40% over the traditional Italian basin oven
- Temperature in cooking basin and reeling basin remained uniform at desired level
- Gasifier based system provided improved environmental working conditions (less smoke) inside the reeling unit shed.

Following suggestion were given for future course of action:

- Explore the possibility of providing common cooking bath (in the line of Ramanagaram model) for two tables, which may reduce fuel consumption further and improve silk yarn quality as well as yield
- It is essential to develop alternative mechanism to dry silk, as present gasifier system does not produce sufficient residual charcoal unlike traditional oven.

Mr B M Gurumurthy

Mr Gurumurthy concurred with Mr Anantha Padmanabha's observations/ feedback. He stressed on the importance of silk drying, and thus the requirement of developing an alternative mechanism for silk drying. He cautioned that until this aspect is addressed and full package is developed, it might not be acceptable to the reeler community. Thus according to him developing alternative mechanism for silk drying would be pre-requisite for system commercialization. According to him apart from fuel saving improving working environment is one of the major benefits of gasifier system. He felt that gasifier system also reduces overall heat dissipation within the reeling shed thus resulting in much comfortable lower surrounding temperature levels.

Manufacturer's views

Mr Mohan Kulkarni, 2 M Industries, Mumbai

Mr Kulkarni mentioned that 2 M Industries have an understanding by means of a licensee agreement with TERI to produce gasifier-based cocoon cooking systems. The field prototype units demonstrated in the reeling units before the workshop were fabricated by 2M Industries based on the drawings supplied by TERI. He mentioned that it is heartening to note interest taken by various stakeholders on the gasifier-based systems in this workshop.

He informed that the present estimated system cost is about Rs.15,000 excluding oven, since in the present configuration gasifier system is being developed as an attachment to existing conventional oven structure. It may be possible to reduce the production cost further through design optimization and also if more number of systems are fabricated.

Mr P M Madhav Rao, M/s Silk Tex, Kanakapura

Mr Madhava Rao represented M/s Silk Tex of Kanakapura who is another licensed manufacturer with TERI on gasifier based system for cocoon cooking oven. He concurred with Mr Kulkarni on the issues involved in manufacturing of the system and its estimated cost. He also mentioned that gasifier based system has potential to save fuel and reduce pollution, and hence is likely to be useful to reelers as well as operators working in the reeling units.

Observations from DoS officials

Mr V L Krishnamurthy, Sericulture Inspector, TSC (Reeling), Siddlaghatta said that the field testing of gasifier based Italian basin oven proved its successful operation under field conditions. However he felt that though gasifier system can save about 40% fuel, the fact that the present gasifier based system does not produce charcoal will offset some of this saving and thus the ultimate saving could actually will be about 30%. According to him apart from saving of fuelwood, gasifier provides excellent working condition as it does not create smoky atmosphere as well as the low heat loss to atmosphere so comparatively less hot ambience. He stressed importance of efficient technology like gasifier a saving of fuel reduces stress on forest and thus reduces stress on environment.

He mentioned that if TERI can come up with an alternative to silk drying, it would be an excellent solution and the whole package of gasifier based system with silk drying facility will be an attractive acceptable proposition to the reelers.

Comments by SERI-2000, SDC, Bangalore

Ms H R Girija, explained briefly the development stages of gasifier based reeling system from `Mark 2' in Hindupur to present `Mark 4' developed by TERI in past under SERI-2000 programme. She mentioned that TERI has been actively involved in the development of the gasifier technology for Ramanagaram type silk reeling industry and involved concerned stakeholders namely reelers, silk experts, consultants and manufacturers at each stages for the development of the gasifier technology. TERI is one of the unique organizations that is keenly involved and concerned in the development of energy efficient and environment friendly technologies and gave adequate importance to the concerns of the users. Similarly, she said that it is important to note that TERI has involved reelers and DoS officers for the further development of the gasifier systems for Siddlaghatta type cottage basin ovens. It is very difficult to make any success in endeavours without co-operation and feedback from users, concerned professionals, experts and concerned departments officers. Thus it is expected that inputs and co-operation would be extended to TERI for the further development of the commercial model of the gasifier systems for the Siddlaghatta reeling cluster. At the end she wished that all efforts would be made to make the system user-acceptable and to reduce the cost of the systems at the commercial stage.

Discussions (Questions and Answers Session)

Question: Are there any more suggestions to further improve the gasifier system? (Mr S N Srinivas)

Answer: In the present gasifier system charcoal is not available. Silk drying is an important parameter in silk reeling industry and there is need to develop alternate mechanism/system to dry silk yarn during reeling operation (Anantha Padmanabha)

Question: Is it possible to design common cooking bath? (Anantha Padmanabha)

Answer: Yes, it is possible to do the single cooking bath. (Dr V V N Kishore)

Question: What is your opinion about the present gasifier system (S N Srinivas to Gurumurthy)?

Answer: Except the silk yarn drying, the other performances of the gasifier system are good. So if TERI addresses silk drying problem, definitely reelers will show interest in the gasifier system.

Answer: Yes, we will be concentrating on this issue during the next phase of the project work and hopefully some simple economical solution would be worked out soon. (Dr Kishore).

Question: We agree with the performance and advantages of gasifier system, but we would like to know about cost of the system. (Reeler)

Answer: Approximate estimated cost of the present system (gasifier, burner excluding masonry oven structure cost) is about Rs. 15,000, but this is not exact value of the system as this is not final product, some modifications are expected. After commercial model is finalized, the manufacturers may be able to fix the cost of the gasifier system. (Ms H R Girija)

Question: Is it possible to provide any subsidy on these systems? (Reeler)

Answer: We are rather thinking to reduce the cost through cutting manufacturing costs. It also can perhaps be further reduced if more number of systems are produced. (Girija)

Question: You have designed present system only for two tables. Is it possible to design for more than two tables (Reeler)?

Answer: Yes. It is possible (Dr. Kishore)

Answer: In Siddlaghatta more number of reelers has two tables (four reeling basins). This is the reason, why we have developed gasifier system for two tables (Srinivas)

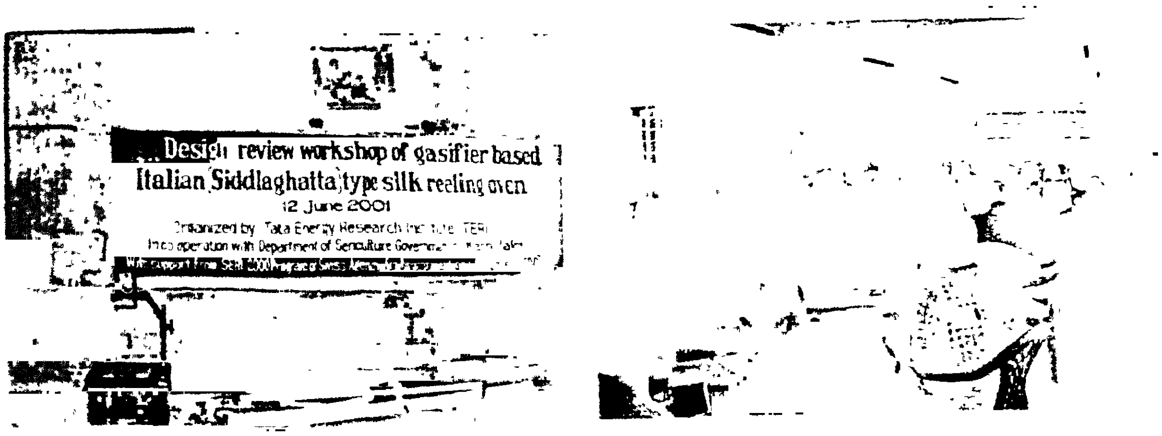
Vote of Thanks

On behalf of Director of Tata Energy Research Institute, Mr S N Srinivas thanked Ms Girija and SERI-2000 programme officials, who came from Bangalore to participate in this workshop. He also thanked the SDC team for their valuable inputs at various stages of this project. He thanked SDC for sponsoring this workshop, which is part of this phase of the project.

He thanked Mr Kulkarni, 2M Industries, Mumbai and Mr Madhava Rao, representative from M/s Silk Tex, Kanakapura (Manufacturer) who have participated in this workshop despite their busy schedules at their factories. He thanked all the reelers specially Mr. Anantha Padmanabha and Mr Gurumurthy for participating in the workshop and their valuable feedback on the prototype gasifier based Italian oven to other audience in the workshop.

He thanked all the DoS officials from TSC, Cocoon Markets, Grainage and Bangalore office especially director from KSSRDI Thalaghatapura and his colleagues. He thanked Director of DoS and Additional Director not only for providing space to conduct workshop actively but also observing the demonstration of gasifier based system at Mr Gurumurthy's reeling unit with keen interest. He thanked all colleagues who directly and indirectly involved in organizing this workshop.

Figures 6.3 (a-d) depict some events during the proceedings of the design review workshop.


Design review workshop of gasifier based
Italian Siddlaghatta type silk reeling oven
12 June 2001
Organized by Tata Energy Research Institute TERI
In co-operation with Department of Sericulture Government

(a) Design review workshop dias

(b) Welcome and introduction to workshop

(c) Presentation of overview of project

(d) Discussions

Figure 6.3 a-d. Some moments during the proceedings of design review workshop

7

Conclusions and recommendations

In the present phase of the project, sponsored by SDC under its SERI-2000 programme, TERI had successfully field-tested the gasifier-based Italian (Siddlaghatta type) cottage basin oven in two units at Siddlaghatta for quantification of its benefits to arrive at techno-economic feasibility. Firstly the design of "Mark 1" field prototype was arrived at by modifying the "Mark 0" laboratory prototype developed in the last phase to make it easy to fabricate and operate in the field. The two-field prototype were got fabricated from M/s 2M Industries, Mumbai as per the detailed technical drawings prepared.

Two field testing sites, namely Mr B M Gurumurthy and Mr Anantha Padmanabha, were identified in Siddlaghatta in consultation with DoS-Karnataka. After fabrication of the system the systems were installed at selected sites in November-December 2000. Initial successful trial runs helped to gain confidence of the reelers and operators of the reeling units in the new gasifier technology and also gave some useful feedback for fine tuning the system to suit local field conditions of individual field testing site.

During the trial runs it was felt that it would be essential to either have electric back up or some alternative mechanism/arrangement to run the system during power cuts to enable collection of long duration continuous comparative performance data of the conventional as well as gasifier based system. TERI could successfully develop alternative mechanism of coupling blower required for the gasifier operation to one of the existing reeling shaft that would ensure that whenever the reeling operation is going on the gasifier can be operated. Though this was unplanned activity, which consumed lot of time and effort (resulting in some delay) it would definitely help in future to enhance the acceptability of gasifier system as now there won't be necessity to have generator back requiring additional capital investment.

The gasifier system was operated successfully for long duration and its performance was monitored for its comparative performance with that of conventional system. It was observed that apart from saving 30-40% firewood consumed in cocoon cooking oven gasifier system gives numerous other benefits. The major benefits of gasifier based system over conventional Italian oven are:

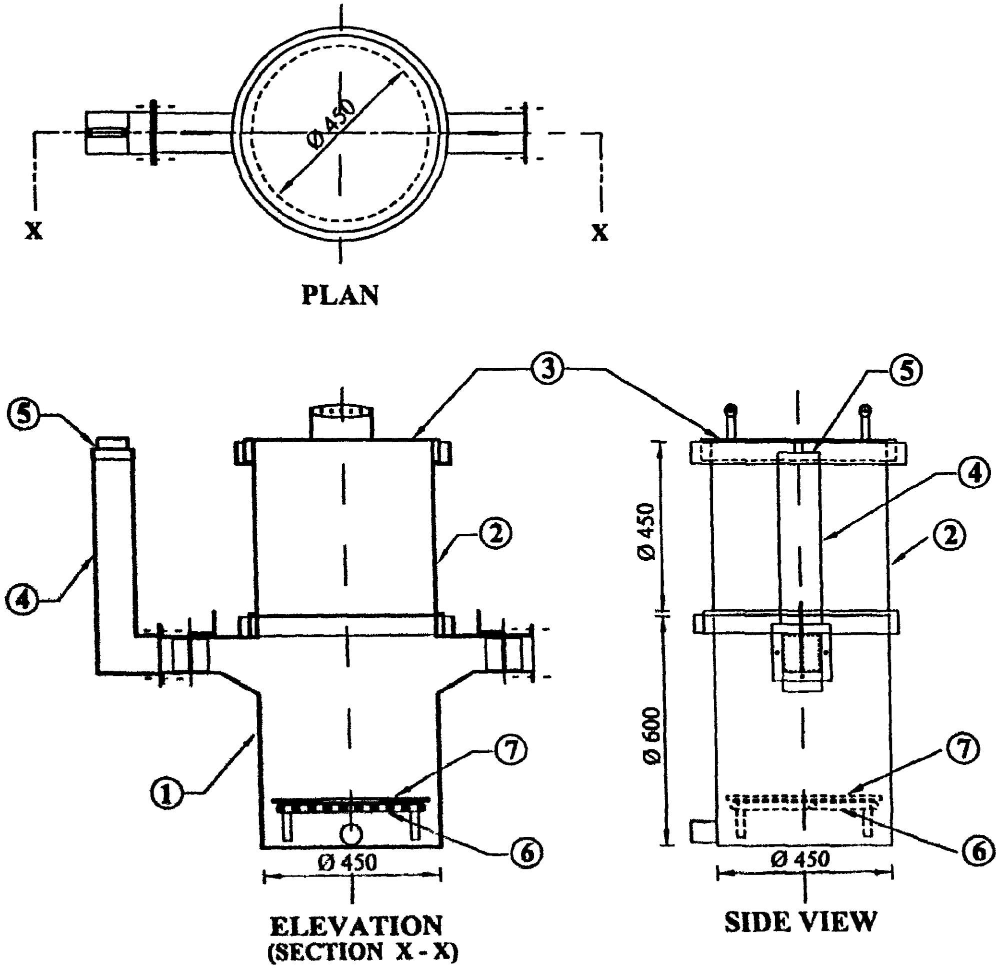
- Reduction in fuelwood consumption of the order of 30-40%
- Improvement in working conditions due to less smoke levels as well as less heat (loss) dissipated into ambience due to improved energy efficiency
- Uniform consistent heat input to cooking basin due to controlled gaseous fuel burning
- Improvement in quality of silk yarn as well as yield (reducing renditta)

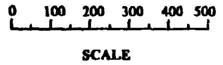
During the project design review workshop held on 12 June 2001 at Siddlaghatta the progress made during this phase of the project in developing the gasifier-based Italian (Siddlaghatta cottage basin type) oven system was reviewed. All the participants appreciated the gasifier system performance under actual field conditions during the demonstration as a part of this workshop. Many reelers observed that apart from fuelwood saving improving working conditions is one of the useful benefits. It was however felt that in order to make the systems acceptable to reelers it would be essential to find out some alternate mechanism or system for silk yarn drying before launching the system for its large-scale promotion.

With the background of the successful field testing of the system and feedback received from the design review workshop, the objective of the next phase of the project should be to develop an improved system design which will incorporate the viable option for silk yarn drying. This will help in enhancing the acceptability of the system by majority of the reelers. Some more improvisation in the system can be done so as to make it more user friendly, based on inputs received during the project review workshop.

Annexure 1

Detailed Technical Drawings of Gasifier based Italian Cottage Basin (Siddlaghatta type) Oven System





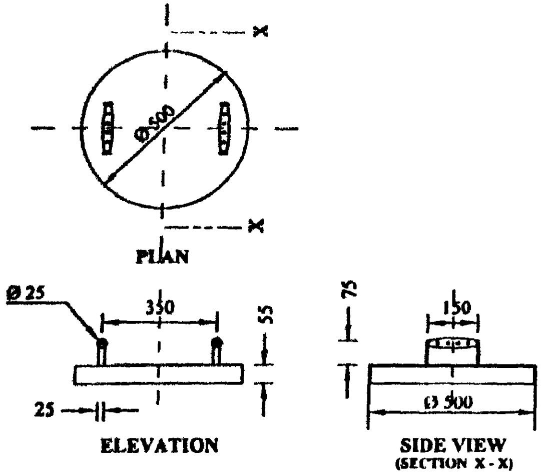
PART NO	PARTICULARS	MATERIAL	QUANTITY
7	GRATE CONTROL PLATE	MS	1
6	GRATE	SS	1
5	GAS FLARING DUCT COVER	GI	1
4	GAS FLARING DUCT	MS	1
3	FUEL CHARGING DOOR	MS	1
2	FUEL HOPPER	MS	1
1	MAIN GASIFIER SHELL	MS	1

TATA ENERGY RESEARCH INSTITUTE (TERI),
HABITAT PLACE, LODHI ROAD, NEW DELHI - 3

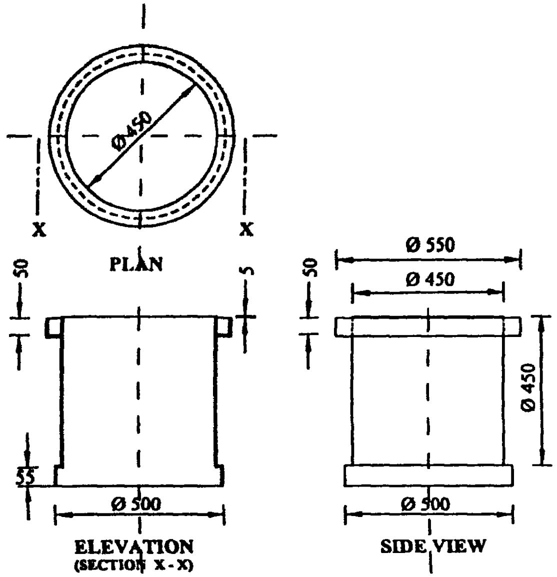
MAIN TITLE GASIFIER SYSTEM FOR ITALIAN BASIN OVEN

SUB TITLE UPDRAFT GASIFIER MARK 8'
ASSEMBLY DETAILS

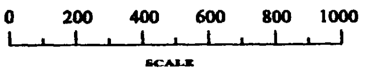
DRG NO TERI/BETA/2000BE42/UG10-0-01		SCALE	REV NO 01
DATE	DRAWN BY	CHECKED BY	APPROVED BY

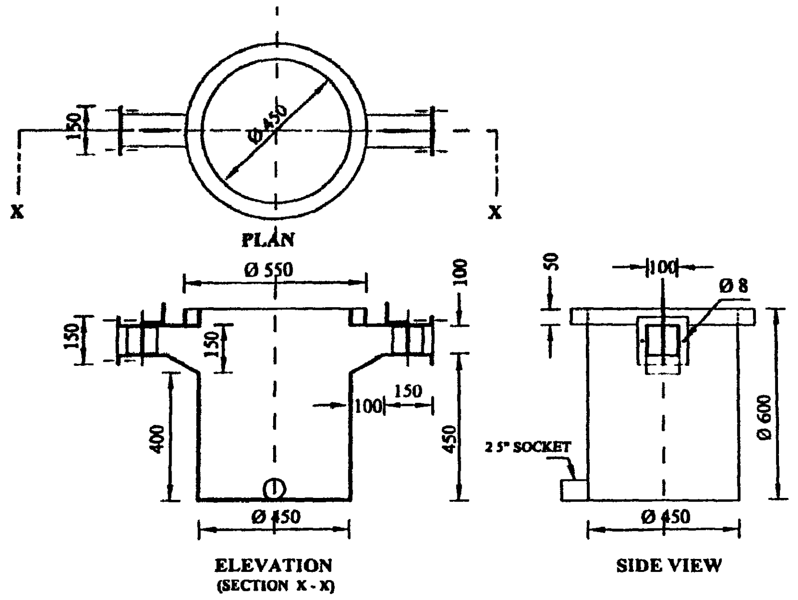


3. FUEL CHARGING DOOR



FUEL HOPPER





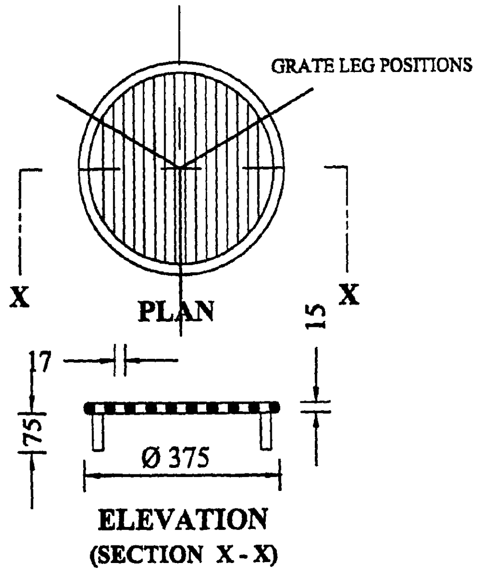
1. MAIN GASIFIER SHELL

ALL DIMENSIONS ARE IN MM

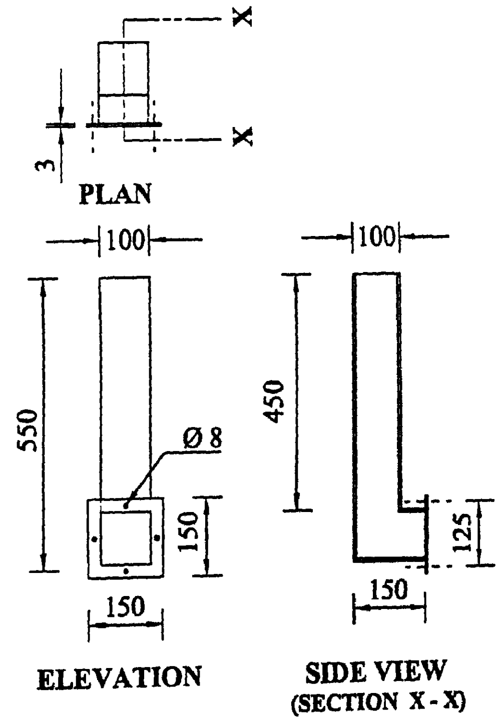
3	FUEL CHARGING DOOR	MS	1
2	FUEL HOPPER	MS	1
1	MAIN GASIFIER SHELL	MS	1
PART NO	PARTICULARS	MATERIAL	QUANTITY

TATA ENERGY RESEARCH INSTITUTE (TERI),
BABITAT PLACE, LODHI ROAD, NEW DELHI - 3

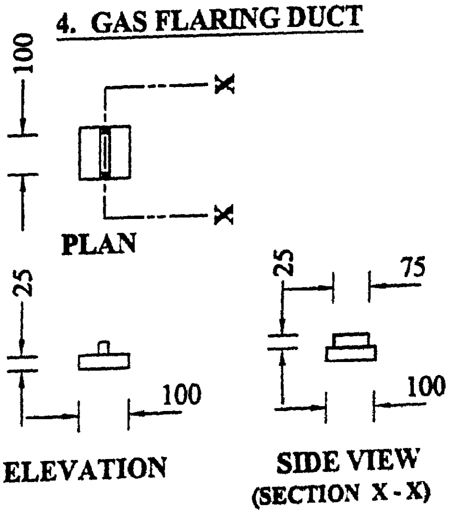
MAIN TITLE	GASIFIER SYSTEM FOR ITALIAN BASIN OVEN		
SUB TITLE	UPDRAFT GASIFIER 'MARK 0' COMPONENT DETAILS (PART 1,2,3)		
DRG NO TERI/BETA/2000BE42/UG10-0-02	SCALE		REV NO 01
DATE	DRAWN BY	CHECKED BY	APPROVED BY



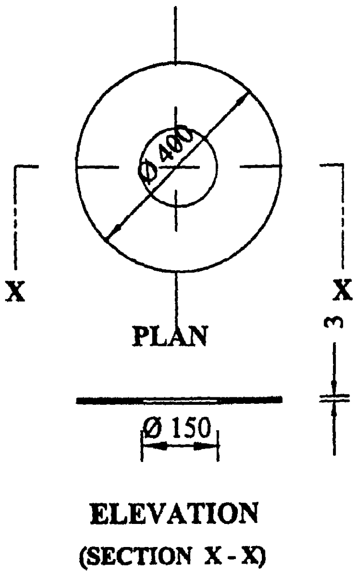
6. GRATE



4. GAS FLARING DUCT



5. GAS FLARING DUCT COVER



7. GRATE CONTROL PLATE

ALL DIMENSIONS ARE IN MM

7	GRATE CONTROL PLATE	MS	1
6	GRATE	SS	1
5	GAS FLARING DUCT COVER	GI	1
4	GAS FLARING DUCT	MS	1
PART NO	PARTICULARS	MATERIAL	QUANTITY

TATA ENERGY RESEARCH INSTITUTE (TERI),
HABITAT PLACE, LODHI ROAD, NEW DELHI - 3.

MAIN TITLE GASIFIER SYSTEM FOR ITALIAN BASIN OVEN

SUB TITLE UPDRAFT GASIFIER
COMPONENT DETAILS (PART 4,5,6)

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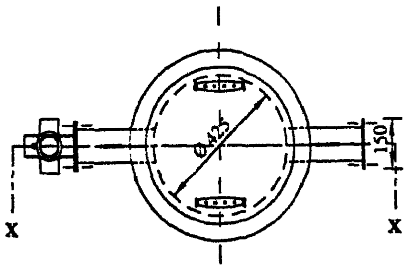
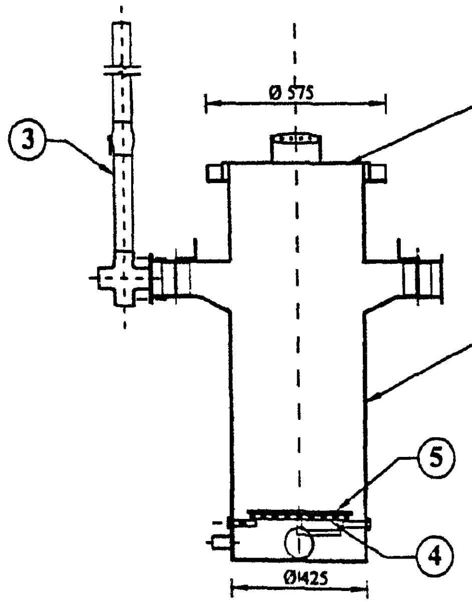
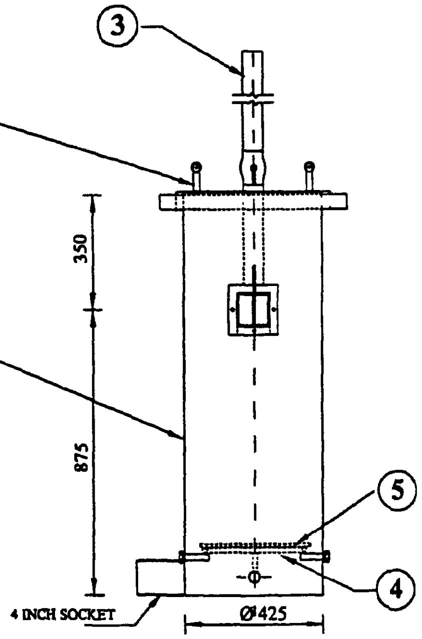
DATE	DRAWN BY	CHECKED BY	APPROVED BY



PLAN





ELEVATION
(SECTION X - X)

SIDE VIEW

GASIFIER INSULATION
ACC WHYTEHEAT GRADE K CASTABLE INSULATION
UPTO 1600 C TEMPERATURE RANGE
40 MM THICK ON INNER SIDE OF MAIN GASIFIER SHELL
40 MM THICK ON INNER BOTTOM SIDE OF MAIN GASIFIER SHELL

ALL DIMENSIONS ARE IN MM

0 200 400 600 800 1000

SCALE

5	GRATE CONTROL PLATE	MS	1
4	GRATE	SS	1
3	GAS FLARING PIPING	GI	1
2	FUEL CHARGING DOOR	MS	1
1	GASIFIER SHELL	MS	1
PART NO	PARTICULARS	MATERIAL	QUANTI

TATA ENERGY RESEARCH INSTITUTE (TERI),
HABITAT PLACE, LODHI ROAD, NEW DELHI - 3.

MAIN TITLE GASIFIER SYSTEM FOR ITALIAN BASIN OVEN

SUB TITLE UPDRAFT GASIFIER 'MARK 1' ASSEMBLY

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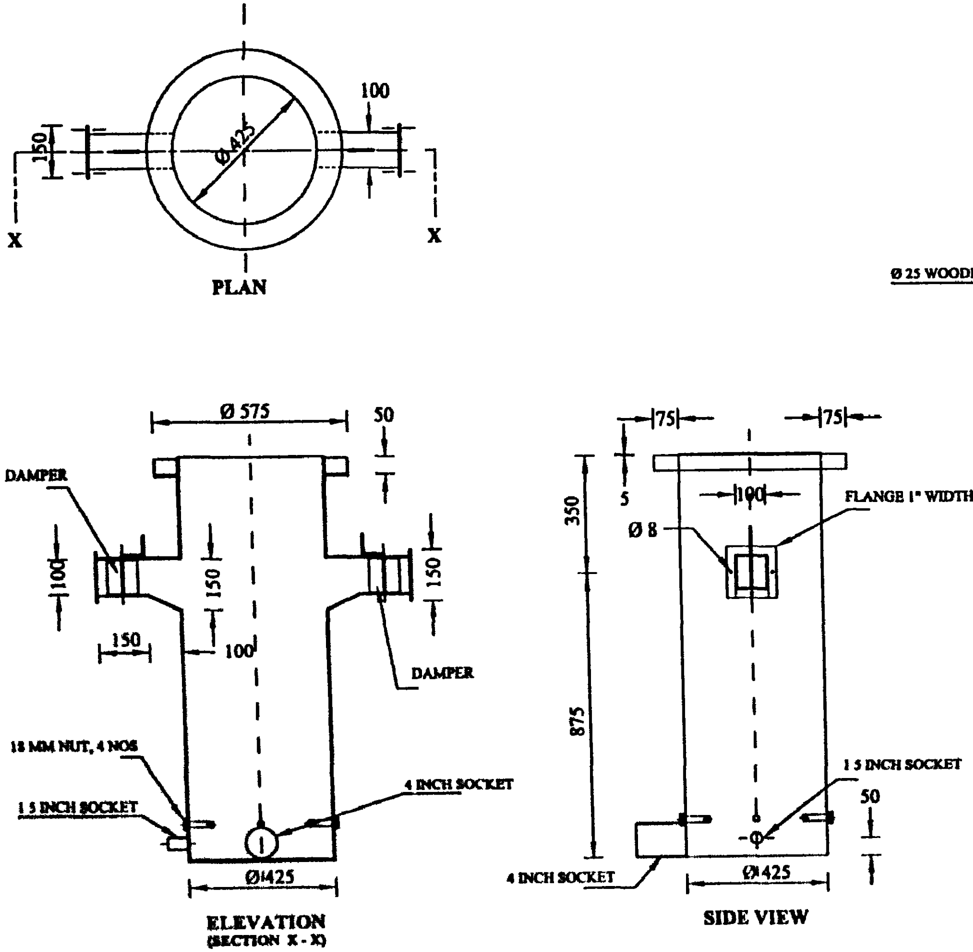
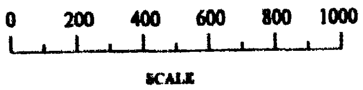
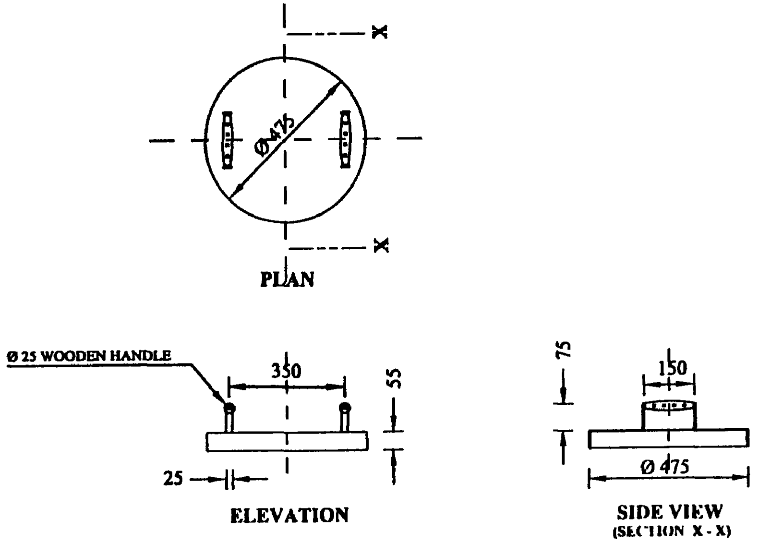
DATE	DRAWN BY	CHECKED BY	APPROVED



1. GASIFIER SHELL





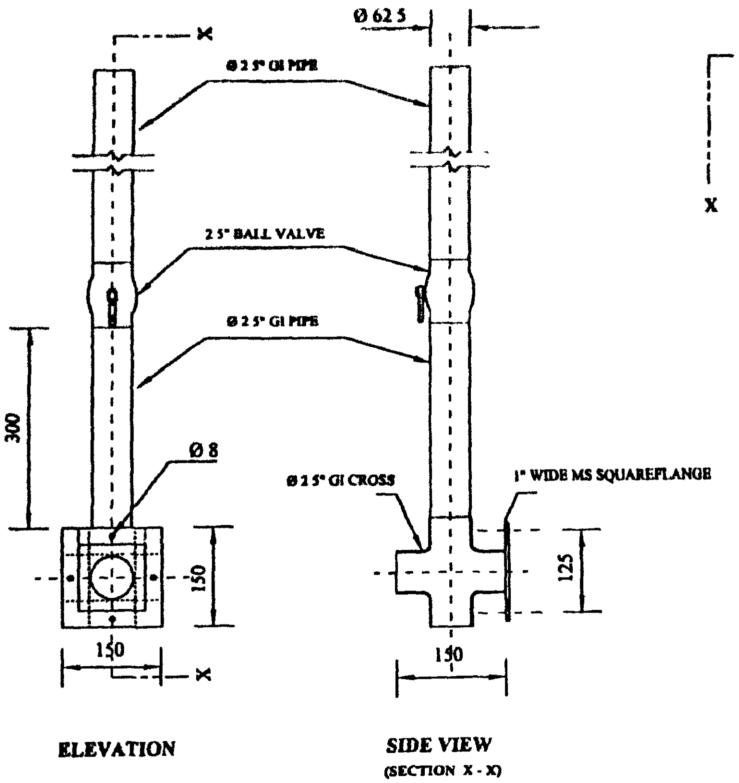
2. FUEL CHARGING DOOR

ALL DIMENSIONS ARE IN MM
MATERIAL 2 MM MS SHEET

2	FUEL CHARGING DOOR	MS	1
1	GASIFIER SHELL	MS	1
PART NO	PARTICULARS	MATERIAL	QUANTITY

TATA ENERGY RESEARCH INSTITUTE (TERI),
HABITAT PLACE, LODHI ROAD, NEW DELHI - 3

MAIN TITLE	GASIFIER SYSTEM FOR ITALIAN BASIN OVEN		
SUB TITLE	UPDRAFT GASIFIER MARK I' COMPONENT DETAILS (PARTS 1, 2)		
DRG NO TERI/BETA/2000BE42/UG10-1-02	SCALE		REV NO 01
DATE	DRAWN BY	CHECKED BY	APPROVED BY



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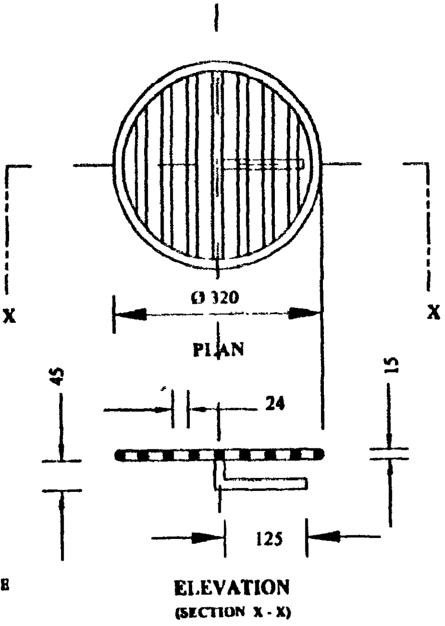
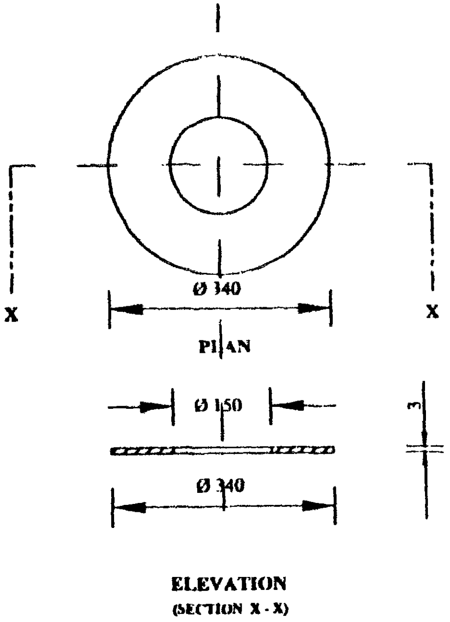
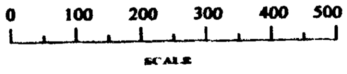


4. GRATE



5. GRATE CONTROL PLATE

GRATE
SS ROD DIAMETER - 15 MM
GAP BETWEEN TWO RODS - 23-25 MM



ALL DIMENSIONS ARE IN MM

5	GRATE CONTROL PLATE	MS	1
4	GRATE	SS	1
3	GAS FLARING PIPING	GI	1
PART NO	PARTICULARS	MATERIAL	QUANTITY

TATA ENERGY RESEARCH INSTITUTE (TERI),
HABITAT PLACE, LODHI ROAD, NEW DELHI 3

MAIN TITLE	GASIFIER YSTEM FOR ITALIAN OVEN		
SUB TITLE	UPDRAFT GASIFIER MARK I' COMPONENT DETAILS (PART 3,4,5)		
DRG NO TERI/BETA/2000BB42/UG10-1-03		SCALE	REV NO 01
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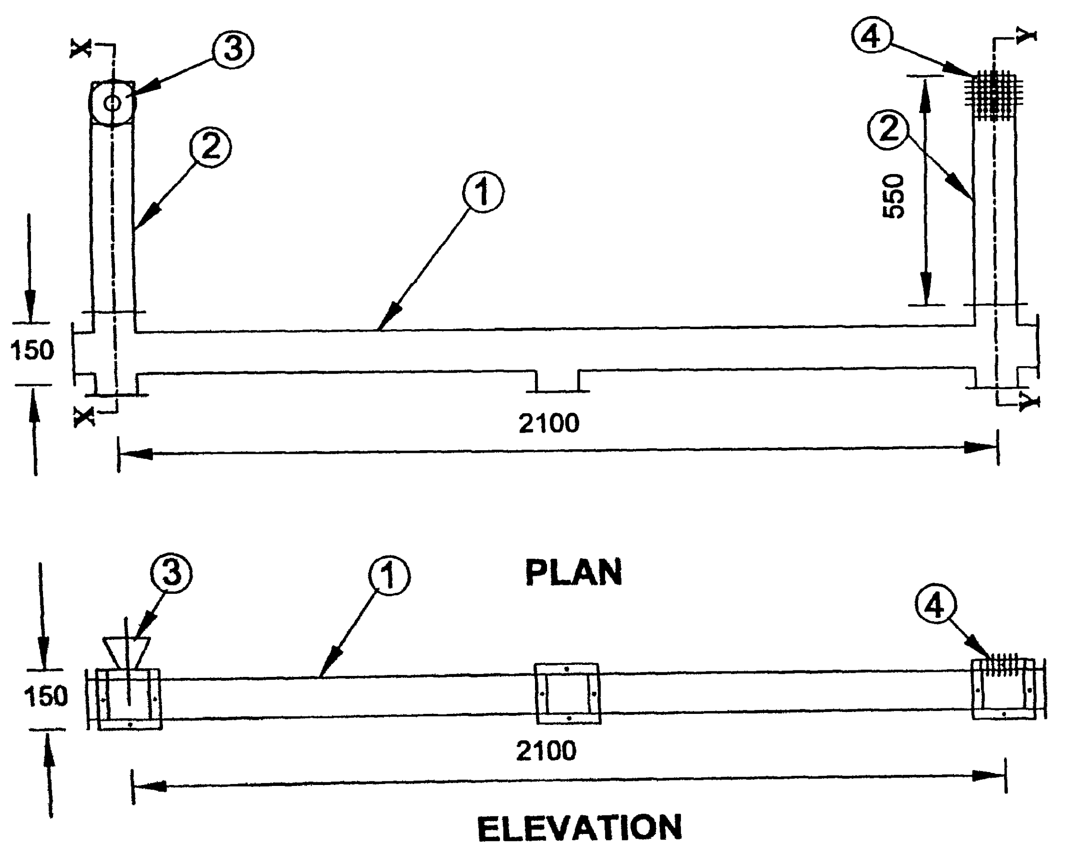
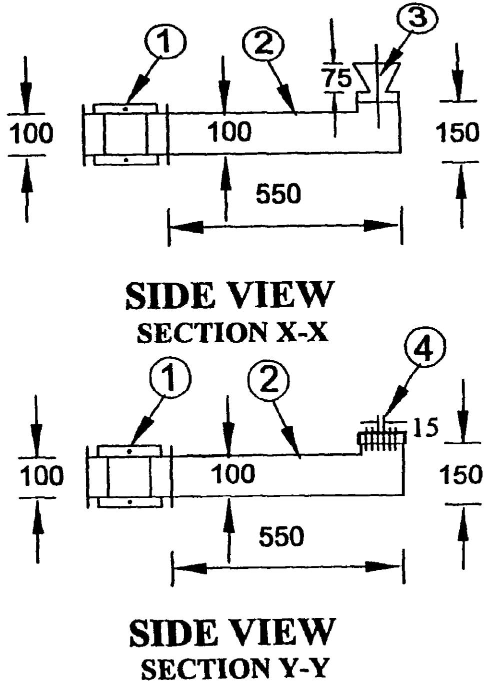
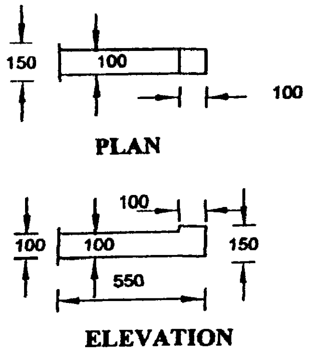




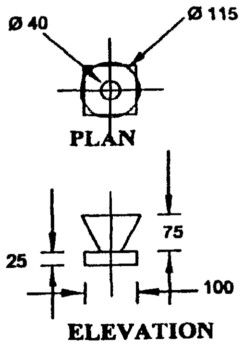
4	SQUARE BURNER	MS	2
3	CONICAL BURNER	MS	2
2	BRANCH DUCT	MS	2
1	MAIN GAS DISTRIBUTING DUCT	MS	1
PART NO	PARTICULARS	MATERIAL	QUANTITY

TATA ENERGY RESEARCH INSTITUTE (TERI),
HABITAT PLACE, LODHI ROAD, NEW DELHI - 3.

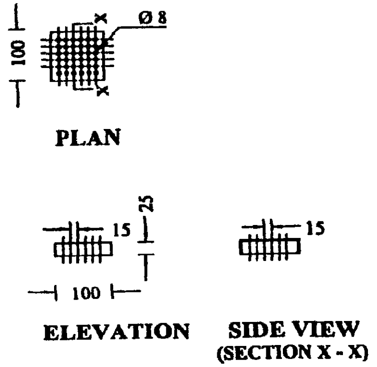
MAIN TITLE	UPDRAFT GASIFIER SYSTEM FOR ITALIAN COTTAGE BASIN OVEN		
SUB TITLE	BURNER ASSEMBLY		
DRG NO TERI/BETA/2000BE42/UG10-B-01		SCALE	REV NO 02
DATE	DRAWN BY	CHECKED BY	APPROVED BY



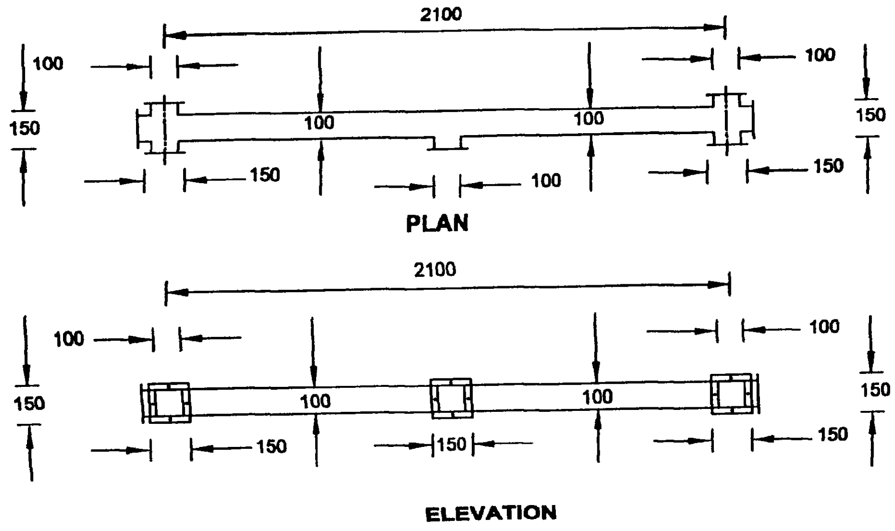
2. BRANCH DUCT



3. CONICAL BURNER



4. SQUARE BURNER



1. MAIN GAS DISTRIBUTING DUCT

ALL DIMENSIONS ARE IN MM

PART NO	PARTICULARS	MATERIAL	QUANTITY
4	SQUARE BURNER	MS	2
3	CONICAL BURNER	MS	2
2	BRANCH DUCT	MS	2
1	MAIN GAS DISTRIBUTING DUCT	MS	1

TATA ENERGY RESEARCH INSTITUTE (TERI),
HABITAT PLACE, LODHI ROAD, NEW DELHI - 3.

MAIN TITLE	UPDRAFT GASIFIER SYSTEM FOR ITALIAN COTTAGE BASIN OVEN
SUB TITLE	BURNER COMPONENTS

DRG NO TERI/BETA/2000BB42/U110-B-02	SCALE	REV NO 02
DATE / DRAWN BY	CHECKED BY	APPROVED BY

Annexure 2

Agreement with selected reelers for field testing

10 Rs.

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INDIA

TEN RUPEES

10 RS

MEMORANDUM OF UNDERSTANDING

30-11-2000

This Memorandum of Understanding is drawn up on 30th day of Nov. 2000 between TATA ENERGY RESEARCH INSTITUTE whose registered office is situated at Darbari Seth Block, Habitat Place, Lodhi Road, New Delhi-110 003 (hereinafter called "TERI") and S.N. Gurumurthy whose address is situated at S/o B.N. Narayanappa Kote Siddlaghatta (hereinafter called " reeler") Phone 08155-56430

WITNESSETH THAT WHEREAS

1. WHEREAS TERI has developed "Gasifier system" (hereinafter referred to as "GASIFIER") for the purpose of use in Italian cottage basin silk reeling (Siddlaghatta type) unit. Based on the simulated laboratory trial testing of the unit, it is expected that the system would reduce the firewood consumption by about 40-50% when compared to the firewood consumption in conventional oven. Also, there are other likely benefits such as reduction in renditta, improvement in silk yarn quality, which have been achieved with gasifier system in other cottage basin silk reeling clusters.

2. WHEREAS, USER has agreed to offer cooperation in installation and field testing of gasifier system in his unit to ascertain its performance.

3. TERI will provide the following for the purpose of demonstration and testing:

a. Gasifier system for Italian cottage basin oven along with other subsystems such as gas distribution duct, gas burner, blower tentatively valued at Rs 65,000 (Sixty five thousand)
(P.S: Since there is present practice of using dry cut wood in Italian basin, it is expected that the reeler will make arrangement to ensure supply of cut wood, 2-3 inch size at about 10% moisture from the present cut wood fuel supplier. Since pruning can be used in gasifier which are cheaper than wood logs it is expected that even for cutting into smaller size would cost same. However if required the additional cutting cost can be reimbursed for trial period. Once the fuel saving potential is proved, then the user is expected to bear this extra cost as over all fuel cost in absolute term is expected to reduce).

b. Operation and maintenance manual for running the unit.

c. Training for the operators at the field testing site for short duration at he start to help them learn new technology. However it is expected that once the operator gets trained reeler will ensure that the gasifier system is operated regularly for its long duration performance evaluation.

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4. After the expiry of the field testing period USER may decide to purchase the system b paying cost of the system to TERI at depreciated price, otherwise, TERI will have a option of withdrawing the system from the premises.

5. For successful field testing of the gasifier system for ascertaining its performanc following is to be ensured by USER
    a. Utilities like power, water, cut wood (2-3" size and <15% moisture content)
    b. Supply of cocoons during testing of the system
    c. Operators and other field staffs required for running the systems
    d. Free access of personnel from TERI to collect field testing data of both traditiona as well as gasifier system for comparative performance evaluation etc.
    e. Shelter for the system

6. The gasifier system details and other know how provided to USER under th Memorandum of Understanding will be kept as confidential information and USER w not disclose the design/drawings/data to any other person/parties.

7 This Memorandum of understanding is effective from 1/12 2000 2000 will be val upto 30.11. 2001.

8 In witness whereof the parties hereto have executed this Memorandum Understanding through their representatives duly authorized in this behalf as under.

For and on behalf of *Tata Energy Research Institute* *Darbari Seth Block, Lodhi Road* *New Delhi - 110 003*	*For and on behalf of* *USER* *Siddlaghatta*

Witnessed by

(Representative of Department of Sericulture,
Karnataka

10 Rs.

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INDIA

TEN RUPEES

MEMORANDUM OF UNDERSTANDING

.........2000

This Memorandum of Understanding is drawn up on.............. day of .... between TATA ENERGY RESEARCH INSTITUTE whose registered office is situated at Darbari Seth Block, Habitat Place, Lodhi Road, New Delhi-110 003 (hereinafter called "TERI") and [illegible] Umanath whose address is situated at C/o K. Venkatswamy [illegible] Siddlaghatta Phone 08158-[illegible] (hereinafter called " reeler")

WITNESSETH THAT WHEREAS

1. WHEREAS TERI has developed "Gasifier system" (hereinafter referred to as "GASIFIER") for the purpose of use in Italian cottage basin silk reeling (Siddlaghatta type) unit. Based on the simulated laboratory trial testing of the unit, it is expected that the system would reduce the firewood consumption by about 40-50% when compared to the firewood consumption in conventional oven. Also, there are other likely benefits such as reduction in renditta, improvement in silk yarn quality, which have been achieved with gasifier system in other cottage basin silk reeling clusters.

2. WHEREAS, USER has agreed to offer cooperation in installation and field testing of gasifier system in his unit to ascertain its performance.

3. TERI will provide the following for the purpose of demonstration and testing:

a. Gasifier system for Italian cottage basin oven along with other subsystems such as gas distribution duct, gas burner, blower tentatively valued at Rs 65,000 (Sixty five thousand)
(P.S: Since there is present practice of using dry cut wood in Italian basin, it is expected that the reeler will make arrangement to ensure supply of cut wood, 2-3 inch size at about 10% moisture from the present cut wood fuel supplier. Since pruning can be used in gasifier which are cheaper than wood logs it is expected that even for cutting into smaller size would cost same. However if required the additional cutting cost can be reimbursed for trial period. Once the fuel saving potential is proved, then the user is expected to bear this extra cost as over all fuel cost in absolute term is expected to reduce).

b. Operation and maintenance manual for running the unit.

c. Training for the operators at the field testing site for short duration at the start to help them learn new technology. However it is expected that once the operator gets trained reeler will ensure that the gasifier system is operated regularly for its long duration performance evaluation.

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4. After the expiry of the field testing period USER may decide to purchase the system by paying cost of the system to TERI at depreciated price, otherwise, TERI will have an option of withdrawing the system from the premises.

5 For successful field testing of the gasifier system for ascertaining its performance following is to be ensured by USER

   a. Utilities like power, water, cut wood (2-3" size and <15% moisture content)
   b. Supply of cocoons during testing of the system
   c. Operators and other field staffs required for running the systems
   d. Free access of personnel from TERI to collect field testing data of both traditional as well as gasifier system for comparative performance evaluation etc.
   e. Shelter for the system

6 The gasifier system details and other know how provided to USER under this Memorandum of Understanding will be kept as confidential information and USER will not disclose the design/drawings/data to any other person/parties.

7 This Memorandum of understanding is effective from 01-12-2000 will be valid upto 30.11 2001.

8 In witness whereof the parties hereto have executed this Memorandum of Understanding through their representatives duly authorized in this behalf as under:

Himanshu Kail

For and on behalf of
Tata Energy Research Institute
Darbari Seth Block, Lodhi Road
New Delhi – 110 003

For and on behalf of
USER
Siddlaghatta

Witnessed by

1. [illegible]
(Representative of Department of Sericulture, Karnataka)

2. [illegible]

Annexure 3

Protocol and data sheet for comparative performance monitoring of conventional and gasifier based Italian basin ovens

Mr B M Gurumurthy unit (Conventional Italian Oven)

Date	Operation Time (minute)	Cook ing Time (minute)	Cocoon Processed (kg)	Silk Produced (kg)	Wood Consumption (kg)	Renditta	Wood Burning Rate (kg/hr)	Cocoon Processing Rate (kg/hr)	Silk Production rate (kg/hr)
18.12.2001	675	545	18.10	3.08	77.80	5.877	6.916	1.993	0.339
24.02.2001	445	390	13.60	2.12	37.00	6.415	4.989	2.092	0.326
26.02.2001	705	565	17.96	3.56	48.00	5.045	4.085	1.907	0.378
27.02.2001	670	590	18.50	3.26	61.10	5.675	5.472	1.881	0.332
28.02.2001	845	745	28.04	4.61	79.10	6.082	5.617	2.258	0.371
01.03.2001	725	575	14.48	3.96	68.80	3.657	5.694	1.511	0.413
02.03.2001	760	625	12.06	3.83	73.20	3.149	5.779	1.158	0.368
21.03.2001	720	605	21.20	3.74	70.00	5.668	5.833	2.102	0.371
23.03.2001	635	555	23.18	4.54	69.40	5.106	6.557	2.506	0.491
31.03.2001	690	620	21.00	3.69	65.00	5.691	5.652	2.032	0.357
04.04.2001	445	425	11.40	2.03	42.00	5.616	5.663	1.609	0.287
05.04.2001	480	400	14.60	2.52	46.00	5.794	5.750	2.190	0.378
28.05.2001	720	600	22.20	3.68	72.00	6.033	6.000	2.220	0.368
30.05.2001	700	580	21.40	3.54	76.00	6.045	6.514	2.214	0.366
31.05.2001	670	565	20.96	3.44	80.00	6.093	7.164	2.226	0.365
01.06.2001	675	575	20.06	3.44	78.00	5.831	6.933	2.093	0.359
02.06.2001	660	565	20.00	3.36	74.00	5.952	6.727	2.124	0.357
Average	660	560.29	18.75	3.44	65.73	5.513	5.961	2.007	0.366

Mr B M Gurumurthy unit (Gasifier based Italian oven system)

Date	Operation Time (minute)	Cook ing Time (minute)	Cocoon Processed (kg)	Silk Produced (kg)	Wood Consumption (kg)	Renditta	Wood Burning Rate (kg/hr)	Cocoon Processing Rate (kg/hr)	Silk Production rate (kg/hr)
18.12.2001	765	535	17.00	2.88	54.20	5.903	4.251	1.907	0.323
24.02.2001	445	380	13.50	2.08	22.00	6.490	2.966	2.132	0.328
26.02.2001	670	555	18.98	3.81	36.50	4.982	3.269	2.052	0.412
27.02.2001	675	585	20.04	3.58	36.00	5.598	3.200	2.055	0.367
28.02.2001	845	745	27.22	4.58	46.00	5.943	3.266	2.192	0.369
01.03.2001	700	575	14.58	4.00	38.00	3.645	3.257	1.521	0.417
02.03.2001	760	610	14.10	4.72	40.50	2.987	3.197	1.387	0.464
21.03.2001	720	605	23.50	4.23	40.00	5.556	3.333	2.331	0.420
23.03.2001	645	545	19.60	3.88	41.00	5.052	3.814	2.158	0.427
31.03.2001	710	625	20.90	3.74	38.75	5.588	3.275	2.006	0.359
04.04.2001	460	440	12.00	2.15	25.00	5.581	3.261	1.636	0.293
05.04.2001	480	400	14.30	2.49	24.00	5.743	3.000	2.145	0.374
28.05.2001	720	600	22.00	3.61	46.50	6.094	3.875	2.200	0.361
30.05.2001	690	575	20.06	3.52	49.50	5.699	4.304	2.093	0.367
31.05.2001	670	565	18.30	3.08	50.00	5.942	4.478	1.943	0.327
01.06.2001	675	575	19.05	3.37	50.00	5.661	4.444	1.988	0.351
02.06.2001	660	565	20.50	3.54	47.50	5.791	4.318	2.177	0.376
Average	664.12	557.65	18.57	3.49	40.32	5.427	3.618	1.995	0.373

Mr Anantha Padmanabha unit (Conventional Italian oven)

Date	Operation Time (minute)	Cook ing Time (minute)	Cocoon Processed (kg)	Silk Produced (kg)	Wood Consumption (kg)	Renditta	Wood Burning Rate (kg/hr)	Cocoon Processing Rate (kg/hr)	Silk Production rate (kg/hr)
18.12.2001	480	390	19.70	2.77	62.00	7.112	7.750	3.031	0.426
16.01.2001	660	565	36.40	5.22	76.00	6.973	6.909	3.865	0.554
24.01.2001	690	620	33.08	4.60	69.00	7.191	6.000	3.201	0.445
31.01.2001	710	545	16.70	3.61	61.55	4.626	5.201	1.839	0.397
01.02.2001	660	600	30.44	4.56	64.00	6.675	5.818	3.044	0.456
03.02.2001	705	595	32.20	4.78	65.80	6.736	5.600	3.247	0.482
05.02.2001	430	380	21.90	3.39	43.00	6.460	6.000	3.458	0.535
20.02.2001	705	570	36.10	5.20	68.00	6.942	5.787	3.800	0.547
24.02.2001	700	580	31.93	4.91	56.00	6.503	4.800	3.303	0.508
26.02.2001	705	560	31.04	5.07	62.00	6.122	5.277	3.326	0.543
27.02.2001	685	570	29.98	5.04	72.00	5.948	6.307	3.156	0.531
28.02.2001	685	560	32.14	5.07	56.00	6.339	4.905	3.444	0.543
01.03.2001	680	580	31.80	4.80	62.00	6.625	5.471	3.290	0.497
02.03.2001	695	575	30.20	4.32	66.00	6.991	5.698	3.151	0.451
12.03.2001	650	585	29.13	4.81	60.00	6.056	5.538	2.988	0.493
13.03.2001	510	410	18.50	3.20	42.00	5.781	4.941	2.707	0.468
14.03.2001	695	575	31.08	4.68	61.00	6.635	5.266	3.243	0.489
15.03.2001	670	580	34.30	4.68	68.00	7.329	6.090	3.548	0.484
16.03.2001	690	590	34.25	4.78	60.00	7.165	5.217	3.483	0.486
17.03.2001	690	590	35.30	4.76	70.00	7.416	6.087	3.590	0.484
19.03.2001	680	595	30.86	4.23	62.00	7.296	5.471	3.112	0.427
20.03.2001	435	405	20.10	2.84	44.00	7.077	6.069	2.978	0.421
21.03.2001	445	370	20.06	3.05	40.00	6.577	5.393	3.253	0.495

Date	Operation Time (minute)	Cook ing Time (minute)	Cocoon Processed (kg)	Silk Produced (kg)	Wood Consumption (kg)	Renditta	Wood Burning Rate (kg/hr)	Cocoon Processing Rate (kg/hr)	Silk Production rate (kg/hr)
22.03.2001	680	565	28.77	4.27	62.00	6.738	5.471	3.055	0.453
23.03.2001	490	405	18.07	2.68	48.00	6.743	5.878	2.677	0.397
24.03.2001	705	595	29.35	4.46	62.00	6.581	5.277	2.960	0.450
26.03.2001	500	420	16.70	2.89	54.00	5.779	6.480	2.386	0.413
27.03.2001	460	390	18.40	3.11	44.00	5.916	5.739	2.831	0.478
24.04.2001	460	390	15.40	2.06	58.00	7.476	7.565	2.369	0.317
25.04.2001	455	370	13.30	2.16	64.00	6.157	8.440	2.157	0.350
28.04.2001	465	395	12.90	2.30	61.00	5.609	7.871	1.959	0.349
19.05.2001	710	570	25.45	3.91	70.00	6.512	5.915	2.679	0.411
21.05.2001	690	620	22.66	3.56	74.00	6.365	6.435	2.193	0.345
22.05.2001	680	595	25.68	4.08	73.00	6.294	6.441	2.590	0.411
23.05.2001	690	585	29.00	4.42	74.00	6.567	6.435	2.974	0.453
24.05.2001	700	580	30.13	4.46	73.00	6.756	6.257	3.117	0.461
25.05.2001	675	570	28.49	4.43	84.00	6.431	7.467	2.999	0.466
Average	622.03	525.41	26.53	4.03	61.93	6.554	6.034	3.000	0.457

Mr Anantha Padmanabha unit (Gasifier based Italian basin oven)

Date	Operation Time (minute)	Cook ing Time (minute)	Cocoon Processed (kg)	Silk Produced (kg)	Wood Consumption (kg)	Renditta	Wood Burning Rate (kg/hr)	Cocoon Processing Rate (kg/hr)	Silk Production rate (kg/hr)
18.12.2001	440	390	19.46	2.74	33.50	7.102	4.568	2.994	0.422
16.01.2001	670	570	36.20	5.16	45.00	7.020	4.030	3.811	0.543
24.01.2001	680	620	32.97	4.52	40.00	7.294	3.529	3.191	0.437
31.01.2001	645	540	17.65	3.78	34.75	4.669	3.233	1.961	0.420
01.02.2001	695	600	33.00	4.93	38.00	6.694	3.281	3.300	0.493
03.02.2001	700	595	35.35	5.30	39.50	6.670	3.386	3.565	0.534
05.02.2001	430	380	21.80	3.40	25.40	6.421	3.544	3.442	0.536
20.02.2001	705	555	36.00	5.16	37.00	6.984	3.149	3.892	0.557
24.02.2001	710	570	35.05	5.31	31.00	6.601	2.620	3.689	0.559
26.02.2001	710	540	30.92	5.06	40.00	6.111	3.380	3.436	0.562
27.02.2001	685	565	30.33	5.10	35.25	5.947	3.088	3.221	0.542
28.02.2001	685	540	32.40	5.16	32.50	6.285	2.847	3.600	0.573
01.03.2001	650	565	30.56	4.69	33.00	6.516	3.046	3.245	0.498
02.03.2001	690	565	29.80	4.34	31.00	6.866	2.696	3.165	0.461
12.03.2001	695	575	30.25	4.93	35.55	6.136	3.069	3.157	0.514
13.03.2001	515	410	17.83	3.12	23.50	5.724	2.738	2.609	0.456
14.03.2001	700	560	30.86	4.64	39.00	6.651	3.343	3.306	0.497
15.03.2001	700	575	33.70	4.59	39.15	7.342	3.356	3.517	0.479
16.03.2001	710	585	34.43	4.79	34.00	7.195	2.873	3.531	0.491
17.03.2001	720	585	35.20	4.75	39.00	7.411	3.250	3.610	0.487
19 03.2001	680	585	33.37	4.57	37.00	7.302	3.265	3.423	0.469
20 03.2001	520	400	21.70	3.11	25.00	6.977	2.885	3.255	0.467
21 03.2001	445	365	20.93	3.19	22.00	6.560	2.966	3.440	0.524

Date	Operation Time (minute)	Cook ing Time (minute)	Cocoon Processed (kg)	Silk Produced (kg)	Wood Consumption (kg)	Renditta	Wood Burning Rate (kg/hr)	Cocoon Processing Rate (kg/hr)	Silk Production rate (kg/hr)
22.03.2001	695	560	29.69	4.42	39.00	6.724	3.367	3.181	0.473
23.03.2001	500	395	18.98	2.82	25.00	6.741	3.000	2.882	0.428
24 03.2001	705	580	29.67	4.53	37.00	6.550	3.149	3.069	0.469
26.03.2001	470	395	16.95	2.93	28.00	5.785	3.574	2.575	0.445
27.03.2001	475	400	20.50	3.41	26.00	6.012	3.284	3.075	0.512
24.04.2001	465	385	14.01	1.92	28.00	7.297	3.613	2.183	0.299
25.04.2001	470	380	12.80	2.09	33.00	6.121	4.213	2.021	0.330
28.04.2001	480	395	13.65	2.47	35.00	5.526	4.375	2.073	0.375
19.05.2001	690	565	25.89	4.12	48.50	6.284	4.217	2.749	0.438
21.05.2001	690	595	21.56	3.43	47.00	6.286	4.087	2.174	0.346
22.05.2001	700	580	24.25	3.92	47.50	6.189	4.071	2.509	0.405
23.05.2001	705	580	27.40	4.19	49.00	6.533	4.170	2.834	0.434
24.05.2001	700	580	27.04	4.02	50.00	6.728	4.286	2.797	0.416
25.05.2001	675	570	26.81	4.20	51.00	6.391	4.533	2.822	0.442
Average	627	519	26.73	4.07	36.06	6.531	3.462	3.062	0.468

Mr Anantha Padmanabha unit

Date	Specific fuel consumption (kg/kg cocoon)		Fuelwood saving (%)		Renditta Improvement	Increase in silk yield (%)
	Conventional	Gasifier	Kg/kg cocoon basis	Kg/hr basis		
18.12.2001	3.147	1.721	45.301	41.056	0.010	0.137
16.01.2001	2.088	1.243	40.462	41.673	-0.046	-0.661
24.01.2001	2.086	1.213	41.836	41.176	-0.103	-1.411
31.01.2001	3.686	1.969	46.581	37.852	-0.043	-0.927
01.02.2001	2.102	1.152	45.231	43.615	-0.018	-0.273
03.02.2001	2.043	1.117	45.319	39.541	0.067	0.998
05.02.2001	1.963	1.165	40.659	40.930	0.039	0.607
20.02.2001	1.884	1.028	45.437	45.588	-0.041	-0.590
24.02.2001	1.754	0.884	49.571	45.423	-0.098	-1.480
26.02.2001	1.997	1.294	35.233	35.938	0.012	0.190
27.02.2001	2.402	1.162	51.607	51.042	0.001	0.023
28.02.2001	1.742	1.003	42.430	41.964	0.054	0.861
01.03.2001	1.950	1.080	44.615	44.318	0.109	1.673
02.03.2001	2.185	1.040	52.400	52.690	0.124	1.811
12.03.2001	2.060	1.175	42.944	44.586	-0.080	-1.300
13.03.2001	2.270	1.318	41.945	44.591	0.057	1.002
14.03.2001	1.963	1.264	35.610	36.522	-0.016	-0.233
15.03.2001	1.983	1.162	41.401	44.894	-0.013	-0.177
16.03.2001	1.752	0.988	43.630	44.930	-0.030	-0.419
17.03.2001	1.983	1.108	44.127	46.607	0.005	0.073
19.03.2001	2.009	1.109	44.811	40.323	-0.006	-0.088
20.03.2001	2.189	1.152	47.371	52.469	0.100	1.433
21.03.2001	1.994	1.051	47.274	45.000	0.017	0.267
22.03.2001	2.155	1.314	39.036	38.454	0.014	0.209
23.03.2001	2.656	1.318	50.401	48.958	0.002	0.028
24.03.2001	2.112	1.247	40.966	40.323	0.031	0.474
26.03.2001	3.234	1.652	48.913	44.838	-0.006	-0.111
27.03.2001	2.391	1.268	46.962	42.775	-0.095	-1.586
24.04.2001	3.766	1.999	46.919	52.243	0.179	2.451
25.04.2001	4.812	2.578	46.423	50.083	0.036	0.587
28.04.2001	4.729	2.564	45.776	44.416	0.082	1.491
19.05.2001	2.750	1.873	31.892	28.706	0.228	3.633
21.05.2001	3.266	2.180	33.246	36.486	0.079	1.264
22.05.2001	2.843	1.959	31.094	36.791	0.105	1.692
23.05.2001	2.552	1.788	31.905	35.193	0.034	0.519
24.05.2001	2.423	1.849	23.680	31.507	0.028	0.410
25.05.2001	2.948	1.902	35.481	39.286	0.040	0.629
Average	2.483	1.429	42.392	42.508	0.023	0.357
Standard Deviation	0.763	0.445	6.405	5.606	0.072	1.110

Mr B M Gurumurthy unit

Date	Specific. fuel consumption (kg/kg cocoon)		Fuelwood saving (%)		Renditta improvement	Increase in silk yield (%)
	Conventional	Gasifier	Kg/kg cocoon basis	kg/hr basis		
18.12.2001	4.298	3.188	25.826	38.53017	-0.026	-0.443
24.02.2001	2.721	1.630	39.775	40.21739	-0.075	-1.160
26.02.2001	2.673	1.923	28.045	19.986	0.063	1.271
27.02.2001	3.303	1.796	45.608	41.517	0.077	1.377
28.02.2001	2.821	1.690	40.094	41.846	0.139	2.342
01.03.2001	4.751	2.606	45.146	42.795	0.012	0.317
02.03.2001	6.070	2.872	52.677	44.672	0.162	5.407
21.03.2001	3.302	1.702	48.450	42.857	0.113	2.032
23.03.2001	2.994	2.092	30.131	41.838	0.054	1.073
31.03.2001	3.095	1.854	40.099	42.064	0.103	1.840
04.04.2001	3.684	2.083	43.458	42.423	0.034	0.616
05.04.2001	3.151	1.678	46.732	47.826	0.051	0.882
28.05.2001	3.243	2.114	34.830	35.417	-0.062	-1.010
30.05.2001	3.551	2.468	30.518	33.924	0.346	6.077
31.05.2001	3.817	2.732	28.415	37.500	0.151	2.549
01.06.2001	3.888	2.625	37.273	35.897	0.170	3.006
02.06.2001	3.700	2.317	37.376	35.811	0.161	2.787
Average	3.592	2.198	38.497	39.125	0.087	1.704
Standard Deviation	0.845	0.477	7.966	6.157	0.102	1.962

Annexure-4

Comparative field performance data collected on conventional and gasifier based Italian oven

Protocol for making the comparison between Conventional oven with Gasifier based cocoon cooking oven in silk reeling units (Italian basin)

A. General information

General information on the reeling unit. such as name of investigator. head of unit. name of place. experiment code. date of experiment. total time of operation. ambient temperature. selected interval of time etc. are provided in this section in the first page.

B. Wood measurement

The details of wood consumption (in kilograms) in both conventional oven and gasifier based oven will be made separately. The procedure of making these measurements in conventional and gasifier are provided below.

Conventional oven- Wood lot that is likely to be used during the operation is weighed before starting of the oven. Remaining wood is weighed after the batch is completed. Subtracting the weight of remaining wood from the total weight of wood gives the net wood consumed during the operation (batch).

Gasifier based oven- Wood is charged top up before starting of the batch in the hopper of the gasifier. It is topped up again after the batch is completed. Wood from same lot is used for topping up. Wood added during the second topping up is weighed which gives the wood consumed during the period of operation.

Cocoon mixing

Preferably cocoons are procured from the same lot at the purchase stage itself. If the same cocoons of required quantity for testing are not available in the same, different lots are mixed before thoroughly before weighing and putting them basket.

C. Cocoon measurement

The cocoons to be processed are weighed (weighed upto second decimal place). The quantum of cocoons to be processed by individual oven are put in separate baskets and the quantity to be processed per batch is decided by the owner of the unit. Generally, about 4 to 5.5 kg of cocoons are processed by individual oven (Two reeling basin) per batch (8 to 10 kg per day – typically three batches are operated per day in an average reeling unit). A fixed quantity cocoons were weighed before batch starting the batches and were place separately for processing. Weight of remaining cocoons was deducted from the weight of cocoons supplied. to get the net quantity of cocoons actually processed during the batch under observation.

D. Silk measurement

Weight of silk yarn produced from gasifier based system and conventional oven system taken separately after the reeling. Weight is noted upto the third decimal place for the silk produced.

E. Silk waste measurement

The cooking waste and reeling waste together is called silk waste. which does not take into account the pupae waste produced. The silk waste thus produced from conventional and gasifier ovens is weighed separately on the day of testing after drying. The weighing is done on the on the following day of the comparison test.

F. Water measurement

Water is consumed for two main purposes in the reeling unit namely, cocoon cooking and reeling. Each reeling basin has water holding capacity of about 15 liters and the water in these reeling basins should be warm at about 40 C throughout the process. There are cooking vessels to cook cocoons of about 15 liters water capacity which requires a temperature of about 90 to 93 C throughout the process. The water in these vessels and reeling basins need to be changed at certain intervals (as decided by owner according to the quality of cocoons). The water consumed for cooking and reeling is measured separately.

Power measurement

Power measurement is made for both gasifier and conventional system separately. Power is defined as the useful out put (heat output) in kW_{th} measured at the vessel, water as measured and the equation used is given in section I data sheet. This would help in identifying the performance of the system.

Data on cooking cycle

The cooking cycle (The duration involving cooking and reeling of one lot of cocoons by a cooker – this is typically one minute in most of the cases) time on conventional system and gasifier and conventional system separately. The difference of gap in cycle time and cooking time in two different systems provides an insight in to the performance of the system and also requirement of power level.

Instruments will be used as follows

1. Digital stopwatch
2. Temperature indicator
3. Measurement tape
4. Spring balance
5. Arm balance (50g LC) for cocoon &jute waste measurement
6. Arm balance (1g LC) for silk measurement
7. Measuring bucket/Drum.

Conventional Vs Gasifier based ovens
Comparision tests in Silk reeling units

Project: Field testing of gasifier-based Italian oven prototype
Tata Energy Research Institute
Darbari Seth Block, Habitat Place
Lodhi Road, New Delhi - 110 003

Basic data

Section A (General information)

1. Name of the investigator ______________________________

2. Name of the head of unit ______________________________

3. Experiment code ______________________________

4. Date ______________________________

5. Ambient temperature at 7.30 am _______, 10.30 am _____,
12.00 noon ______, 2.30 pm _____

6. General weather condition

Sunny ______: Cloudy: ________; Rain ______

Units used:

- All weight measurements are provided in grams or kilograms
- Time in hour or minutes
- Moisture content in percentage of moisture
- Price in Rs
- Quantity of water in liters

Ratified by

	TERI representative	**Owner/Owner's representative**
Signature		
Name		

A. Wood measurement (Batch Number -1)

Parameter	Conventional oven		Gasifier oven	
Oven number				
	Time	Weight	Time	Weight
(a) Total weight of the lots				
(b) Weight of remaining wood				
Total wood consumed (a) - (b)				
Species of wood used				
Moisture content in the wood				
Calorific value of wood				

A. Wood measurement (Batch Number -2)

Parameter	Conventional oven		Gasifier oven	
Oven number				
	Time	Weight	Time	Weight
(a) Total weight of the lots				
(b) Weight of remaining wood				
Total wood consumed (a) - (b)				
Species of wood used				
Moisture content in the wood				
Calorific value of wood				

A. Wood measurement (Batch Number –3)

Parameter	Conventional oven		Gasifier oven	
Oven number				
	Time	Weight	Time	Weight
(a) Total weight of the lots				
(b) Weight of remaining wood				
Total wood consumed (a) - (b)				
Species of wood used				
Moisture content in the wood				
Calorific value of wood				

B. Cocoon measurement (Batch Number - 1)

Parameter	Conventional oven		Gasifier oven			
Oven number			Oven – 1		Oven – 2	
	Time	Weight	Time	Weight	Time	Weight
(a) Total weight of cocoons supplied (kg)						
(b) Weight of fresh cocoons remained (kg)						
Net weight of cocoons processed (a) - (b)						
Moisture content in the cocoons						
Lot	Single/Mixed					
Mode of mixing	Randomnly 50% of lots separately					
Quality of cocoons (observation/feedback from owner)	Poor/Medium/Good					
Are the cocoons stifled	(Yes/No)					
If No, what is the reason?						

B. Cocoon measurement (Batch Number – 2)

Parameter	Conventional oven		Gasifier oven			
Oven number			Oven one		Oven two	
	Time	Weight	Time	Weight	Time	Weight
(a) Total weight of cocoons supplied (kg)						
(b) Weight of fresh cocoons remained (kg)						
Net weight of cocoons processed (a) - (b)						
Moisture content in the cocoons						
Lot	Single/Mixed					
Mode of mixing	randomnly 50% of lots separately					
Quality of cocoons (observation/feedback from owner)	Poor/Medium/Good					
Are the cocoons stifled	(Yes/No)					
If No, what is the reason?						

B. Cocoon measurement (Batch Number - 3)

Parameter	Conventional oven		Gasifier oven			
Oven number			Oven one		Oven two	
	Time	Weight	Time	Weight	Time	Weight
(a) Total weight of cocoons supplied (kg)						
(b) Weight of fresh cocoons remained (kg)						
Net weight of cocoons processed (a) - (b)						
Moisture content in the cocoons						
Lot	Single/Mixed					
Mode of mixing	randomly/ 50% of lots separately					
Quality of cocoons (observation/feedback from owner)	Poor/Medium/Good					
Are the cocoons stifled	(Yes/No)					
If No, what is the reason?						

Mode of mixing: Please note random mixing is mixing of cocoons from different lots. 50% of lots separately => Take 50% of cocoons from lot 1 and 50% from lot 2 (if there are two lots) mix them and then use for traditional oven and the rest mix separately for use in Gasifier based oven)

Size of operation (Batch Number – 1)

	Conventional oven	Gasifier oven
Number of reeling basins		
Number of cookers		

Size of operation (Batch Number – 2)

	Conventional	Gasifier
Number of reeling basins		
Number of cookers		

Size of operation (Batch Number – 3)

	Conventional	Gasifier
Number of reeling basins		
Number of cookers		

C. Silk measurement (Batch Number – 1)

Parameter	Italian Basin	Gasifier
	Weight	Weight
Weight of silk		
Cost of silk (selling price- to be procured from reeler or mention the market cost on that day)		
Are silk samples taken?	Yes/No	Yes/No
If yes, from which basins?		
If no, what is the reason?		

C. Silk measurement (Batch Number – 2)

Parameter	Italian Basin	Gasifier
	Weight	Weight
Weight of silk		
Cost of silk (selling price- to be procured from reeler or mention the market cost on that day)		
Are silk samples taken?	Yes/No	Yes/No
If yes, from which basins?		
If no, what is the reason?		

C. Silk measurement (Batch Number – 3)

Parameter	Italian Basin	Gasifier
	Weight	Weight
Weight of silk		
Cost of silk (selling price- to be procured from reeler or mention the market cost on that day)		
Are silk samples taken?	Yes/No	Yes/No
If yes, from which basins?		
If no, what is the reason?		

D. Silk waste (Batch Number -1)

Parameter	**Italian Basin**		**Gasifier**	
	Time	Weight (g)	Time	Weight (g)
Silk waste				
Cost of silk waste				

D. Silk waste (Batch Number -2)

Parameter	**Italian Basin**		**Gasifier**	
	Time	Weight (g)	Time	Weight (g)
Silk waste				
Cost of silk waste				

D. Silk waste (Batch Number -3)

Parameter	**Italian Basin**		**Gasifier**	
	Time	Weight (g)	Time	Weight (g)
Silk waste				
Cost of silk waste				

E. Water consumption

Parameter	**Italian basin (lt)**	**Gasifier basin (lt)**
Load - 1		
Load - 2		
Load - 3		
Load - 4		
Load - 5		
(e) Total quantity of the loads		
(f) Quantity of remaining water		
Total quantity of water consumed (e) - (f)		
Water procured from (tap/drum)		
Quantity of water procured		
Cost of water		

F – Time (Batch Number – 1)

Parameter	**Conventional oven**	**Gasifier oven**
Batch number		
(g) Ignition		
(h) Flame		
(i) Cooking started		
(j) Cooking stopped		
(k) Oven shut down		
(l) Total operation time (g) to (k)		
Total cooking time (i) to (j)		

F – Time (Batch Number –2)

Parameter	Conventional oven	Gasifier oven
Batch number		
(g) Ignition		
(h) Flame		
(i) Cooking started		
(j) Cooking stopped		
(k) Oven shut down		
(l) Total operation time (g) to (k)		
Total cooking time (i) to (j)		

F – Time (Batch Number – 3)

Parameter	Conventional oven	Gasifier oven
Batch number		
(g) Ignition		
(h) Flame		
(i) Cooking started		
(j) Cooking stopped		
(k) Oven shut down		
(l) Total operation time (g) to (k)		
Total cooking time (i) to (j)		

Time-Temperature measurements at Individual vessels
Conventional oven

SN	1		2	
	Time	Temp	Time	Temp
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Time-Temperature measurements at Individual vessels
Gasifier oven

SN	1		2		3		4	
	Time	Temp	Time	Temp	Time	Temp	Time	Temp
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

Cooking cycles

Conventional basin

Cycle No.	VN	CI	CO	Ct
1				
2				
3				
4				
5				
6				
7				
Total				
Average				

Cooking cycle

Gasifier oven

Cycle No.	**Person A**					**Person B**				
	VN	CI	CO	Ct	Comments	VN	CI	CO	Ct	Comments
1										
2										
3										
4										
5										
6										
7										
Total										
Average										

Vessel Identification (on the backside of the sheet)

Other instructions while taking the readings

1 *All time details must be in seconds. Please use stop watch or watch with a least count of at least 1 second*

2 *In the section, comments, write, whether the person cooking is waiting at the oven for the water to get hot, or due to any other problem (W) and Not waiting (NW)*

3 *The number of cycles that need to be monitored for each person should be equal to the number of persons cooking ie If 5 members are engaged in cooking, take data for 5 cycles While taking data for 5 cycles, the ending time, cocoon in time for 6th cycles also should be noted down*

4 *Please note the ambient temperature and humidity before starting these cycles and at the end of the cycles*

Annexure 5

Design review workshop

Programme schedule and list of participants

Design Review workshop on Gasifier based Italian (Sidlaghatta) Type oven

12th June 2001

PROGRAMME SCHEDULE

TIMINGS

9.00 A M to 1 00 P M	Demonstration of gasifier at two units
1 00 P M to 2 00 PM	Lunch
2 00 P M to 2 15 P M	Welcome & Introduction. Dr V V N Kishore
2 15 P M to 2 35 PM	Presentation: Mr Sanjay Mande
2 35 P M to 3 00 PM	Discussions
3 00 P M to 3 10 PM	Observations from DoS officialsDoS
3 10 P M to 3 40 PM	Manufacturers views followed by Discussions (Reelers, manufacturers, TERI, Moderator DoS and SERI-2000
3 40 PM to 4 00 PM	Summary of proceedings and conclusion of workshop
4 00 P M to 4 05 PM	Vote of thanks: S N Srinivas

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